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LIGHT HYDROCARBON AND OXIDANT TRANSPORT STUDIES IN OHIO – 1974

Environmental Sciences Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

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Air pollutant concentrations both in the urban center and over the region were shown to have strong dependence on synoptic weather patterns and in particular to the passage of high pressure systems. The pollutant characteristics of the air within a fresh or recent system that had moved out of Canada exhibited relatively low pollutant loads. After the air mass within the system had been present over the Midwest area for three to four days, pollutant burdens including both hydrocarbons and photochemical oxidant were significantly higher. Winds during this period of higher concentrations were typically from the southwest at moderate speeds. Aircraft data showed that pollutants were frequently widespread over the region and present in one or more layers above the ground and through the lowest several thousand feet of the atmosphere. In areas directly downwind of major urban centers, ozone concentrations were inversely correlated with nitrogen oxide levels.

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ABSTRACT

This report describes a field research study carried out in the Canton, Ohio, area during July, 1974. Light hydrocarbons, oxidant and other air pollution parameters were monitored in the city and in the surrounding area both at ground level and aloft using an instrumented light aircraft.

Air pollutant concentrations both in the urban center and over the region were shown to have strong dependence on synoptic weather patterns and in particular to the passage of high pressure systems. The pollutant characteristics of the air within a fresh or recent system that had moved out of Canada exhibited relatively low pollutant loads. After the air mass within the system had been present over the Midwest area for three to four days, pollutant burdens including both hydrocarbons and photochemical oxidant were significantly higher. Winds during this period of higher concentrations were typically from the southwest at moderate speeds. Aircraft data showed that pollutants were frequently widespread over the region and present in one or more layers above the ground and through the lowest several thousand feet of the atmosphere. In areas directly downwind of major urban centers, ozone concentrations were inversely correlated with nitrogen oxide levels.

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SECTION 1

INTRODUCTION

It has become apparent in recent years that photochemical smog is not exclusively an urban problem as previously thought. Measurements in rural areas of the United States have shown significant ozone concentrations in regions far removed from any known anthropogenic sources. Because the origin of rural as well as urban ozone has ramifications for any attempt to modify existing control strategies, the discovery of elevated rural ozone levels has stimulated a great deal of conjecture within the scientific community about its source. As a result, several mechanisms have been proposed to explain this situation: injection of stratospheric ozone into the troposphere; ozone production from naturally emitted terpenes; transport downwind of urban-generated ozone; and entrapment of urban ozone in a stable inversion layer with subsequent transport and fumigation as the inversion breaks up.

Several studies have been undertaken to determine the source of periodic high ozone concentrations in non-urban areas. The impact of ozone transport from anthropogenic sources has been examined in the midwest(1-7), farwest(8-10), northeast(11-16), and southeast(17-18). Results from these and other studies indicate that the transport of ozone and its precursors into areas downwind of urban centers is an important factor contributing to elevated rural ozone levels.

In order to gain a better understanding of the significance of transport phenomena for ambient air ozone concentrations, the Environmental Protection Agency(EPA) has funded a project to examine the transport of photochemical ozone, as well as measure light hydrocarbon concentrations at several urban, non-urban, and industrial locations throughout the United States. As part of that effort, Washington State University was authorized to carry out a one-month research program in the Canton, Ohio area during July, 1974. This study focused on delineating ozone production and drift within the region so that pollutant transport patterns could be documented. Measurements were accomplished using both ground-based and aircraft monitoring systems.

SECTION 2

CONCLUSIONS

During the month of July, 1974 a series of high pressure systems moved across Ohio from northwest to southeast. At the WSU monitoring site in Canton, Ohio, the passage of these anticyclones resulted in a remarkably symmetrical pattern of increases and decreases in barometric pressure. The situation during July presented a unique opportunity to document the relationships between transitory summertime high pressure systems and ambient ozone concentrations in the Canton area.

Ground and aircraft measurements indicate that it is possible to account for fluctuations in ozone levels at Canton during the passage of an anticyclone by using a three-stage model. During the first phase, clean air is advected into the area by northerly winds associated with the leading edge of the high pressure system. Ozone levels are typically below 80 ppb due to good atmospheric mixing and reduced photochemical ozone formation. Phase two occurs when the high is centered over Ohio and is characterized by stagnate conditions and increased ozone production through local photochemical mechanisms. In phase three, as the trailing edge of the high moves through the area southwest winds remove locally generated pollutants and bring in ozone and its precursors from upwind anthropogenic sources. At this time ozone concentrations in the Canton area are dominated by long range transport from urban areas to the south.

Hydrocarbon data show the same general relationships with synoptic weather patterns. Concentrations were lowest with the advection of a clean air mass over the site and highest when the anticyclone produced stagnate conditions in the area. As the high moved past the station hydrocarbon levels decreased but continued to remain substantially above those measured on the leading edge of the high pressure system.

Within the city of Canton, hydrocarbon levels were highest in the central business district and composition of the ambient hydrocarbon mixture suggested auto exhaust as the primary source.

SECTION 3

EXPERIMENTAL SITE AND TECHNIQUES

This field program began on July 1, 1974 with both ground and aircraft sampling. Continuous measurements of ozone, nitrogen oxides, methane, total hydrocarbons, carbon monoxide and meteorological variables were recorded through July 25, 1974. Aircraft data was acquired everyday except Sundays and July 23 when low clouds grounded the aircraft. The weather was excellent during the study period which, together with minimal instrument down-time, resulted in a very successful field operation.

SAMPLING SITE

The WSU base of operations was in Canton, Ohio. Canton is a city of approximately 350,000 population located 50 miles south of Cleveland. Bag samples for hydrocarbon analysis were collected twice daily at three sites within the Canton metropolitan area. Continuous NO_x, ozone, methane, total hydrocarbon, carbon monoxide and meteorological data were gathered at centrally located Malone College. Satellite sampling stations were to the south in the midst of the downtown section and to the north in a mostly suburban residential area. A map showing these sites is provided in Figure 1.

Canton and vicinity is an industrialized area which includes a wide variety of pollutant sources - steel mill, oil refinery, power plants, etc. Most of these are located in the southern portion of the city. Farm land surrounds Canton to the west, south and east. There are some oil fields to the southeast.

Canton was selected as the northeasterly terminus of an EPA coordinated monitoring network designed to measure pollutant transport in the state of Ohio. Other research groups were located in the southwest in Dayton and Wilmington, Ohio.

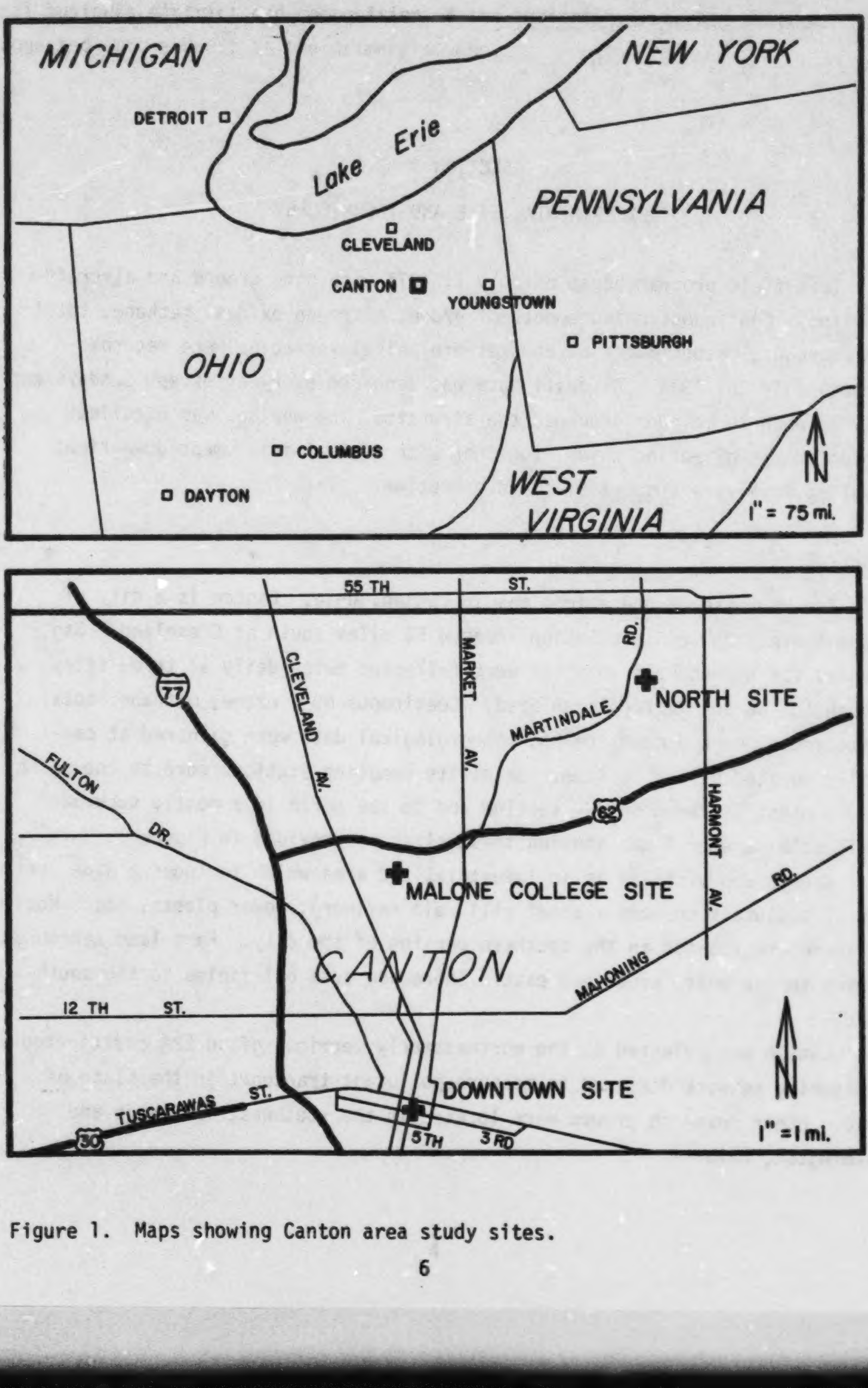

MICHIGAN
NEW YORK
DETROIT
Lake Erie
PENNSYLVANIA
CLEVELAND
CANTON
YOUNGSTOWN
PITTSBURGH
OHIO
COLUMBUS
DAYTON
WEST VIRGINIA
N
1" = 75 mi.
55 TH ST.
CLEVELAND AV.
MARKET AV.
RD.
77
NORTH SITE
MARTINDALE
FULTON DR.
HARMONT AV.
62
MALONE COLLEGE SITE
RD.
CANTON
MAHONING
12 TH ST.
N
DOWNTOWN SITE
TUSCARAWAS ST.
30
5TH
3 RD
1" = 1 mi.

Figure 1. Maps showing Canton area study sites.

SAMPLING TECHNIQUES

WSU sampling operations included both ground and aircraft data collection. The fixed base for ground operations was at Malone College. Instrumentation was housed in a 23-ft trailer.

The following atmospheric gases and meteorological parameters were monitored on a continuous basis using the indicated commercial instruments:

Nitrogen Oxides	Teco 14B (Moly Converter)
Ozone	Meloy OA 350
Carbon Monoxide Methane Total Hydrocarbon	Beckmann 6800 AQGC
Wind Speed Wind Direction Dew Point Temperature Solar Radiation	Climet CI-60

Output from the TECO, Meloy, and Climet systems was recorded on magnetic tape for computer reduction. A high speed printer was interfaced to the data logger for protection against failure of the system and for on-site review of the data.

Measurements for individual light hydrocarbons (C_2 - C_6) were made on Perkin Elmer 900 gas chromatographs with the output channeled into a Hewlett Packard 3352 data system. Stainless steel columns packed with Durapak (n-Octane/Porasil C) were used for separating the hydrocarbons. Details of the hydrocarbon analysis techniques have been published elsewhere (18).

Calibration was performed as follows:

Meloy OA 350 - Once weekly with a McMillan 1000 ozone generator. With this generator, ozone concentrations in the range measured in ambient air (50-100 ppb) could be dependably produced. The ozone generator itself was checked by the wet KI method twice during the study period. Zero checks were made daily.

TECO 14B - Calibrated twice during the sampling period by dilutions into Teflon bags from a high concentration tank (10 ppm). Background suppression checks were made at least once daily.

Beckmann 6800 - Once a day calibration for methane, total hydrocarbon and carbon monoxide from tanks containing standards of known concentration.

Perkin Elmer 900 - An internal standard of known concentration (neohexane; .209 ppm) included in each analysis for light hydrocarbons.

Aircraft instrumentation consisted of a Bendix chemiluminescent ozone monitor (calibrated the same as Meloy OA 350), MRI integrating nephelometer, Environment One condensation nuclei counter and Metrodata system for recording and storing the numerous flight parameters (speed, altitude, rate of climb, position, etc.) as well as the chemical and meteorological variables. In addition to this automatic data logging, ozone levels were recorded continuously on a strip chart recorder. In most cases the pilot assisted in manually mapping the flight path as it progressed.

Integrated samples for light hydrocarbon analysis were collected in 25-liter Teflon bags. These bags were filled over three-hour periods twice a day - 6 to 9 AM and 1 to 4 PM. Komhyr Teflon gas sampling pumps (Science Pump Corp.) were used to fill the bags. Both the pumps and the bags were shown to be free of contamination. In addition to the integrated samples collected on the ground, three to five bags were collected in the aircraft during each flight. Thus, on a typical day a detailed light hydrocarbon analysis was obtained from samples collected at the three ground stations both morning and afternoon and up to ten aircraft collected samples upwind and downwind of Canton.

Two aircraft flights lasting from two to three hours were flown each day. The flight pattern generally began with a spiral climb to 6000' over the trailer at Malone College. After returning to 1000', upwind and downwind loops were flown that extended to 50 miles on each side of Canton. At various points along the loops, touch and go landings were made to monitor ozone levels down to the surface. Bag samples for light hydrocarbon analysis were generally collected at 1000' and 6000' over the trailer plus at designated points along the upwind and downwind loops. The aircraft track and sampling locations for each flight are provided in Appendix B.

SECTION 4

RESULTS AND DISCUSSION

METEOROLOGY

The study period was characterized by a series of high pressure weather systems crossing Ohio from northwest to southeast. In most cases these air masses originated in the polar continental area of central Canada. The fact that these systems followed one another very closely resulted in a remarkably symmetrical pattern of increases and decreases in barometric pressure throughout the month of July. This is illustrated below in Figure 2.

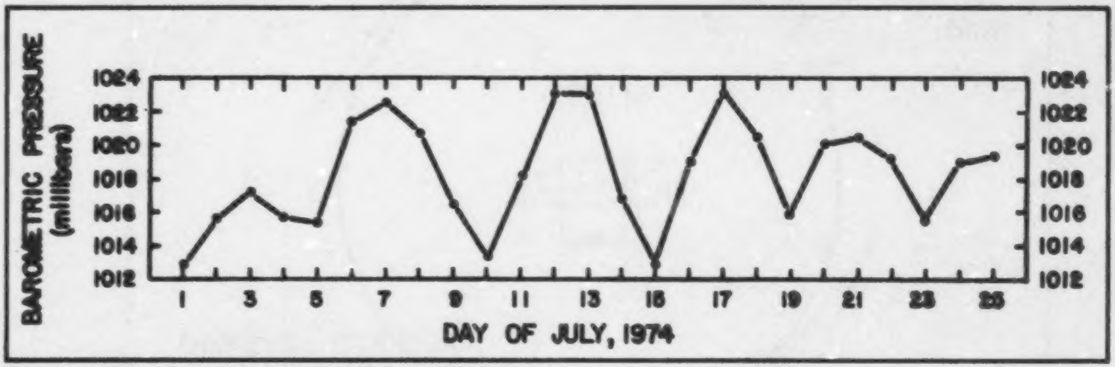


Figure 2. Canton barometric pressure.

It can be seen that the time a particular anticyclone influenced Canton varied from 3 to 4 days. Associated with the passage of these highs were three distinct wind conditions.

(1) As the air mass approaches, winds are from a northerly direction. This then brings air into the Canton area that has been transported over the Great Lakes region from Canada. Typically, afternoon wind speeds during this time vary between 10 and 14 knots. July 6, 11, and 16 are examples of this phase.

(2) The second phase occurs after the leading edge has passed and Canton falls inside the flow pattern of the high. This is a period of low ventilation with afternoon wind speeds generally less than 5 knots. Well developed early morning inversions accompany this stagnation period. July 7, 12, and 17 are good examples of this phase.

(3) As the high continued its southeasterly movement, winds pick up again but now from the southwest. This southwesterly flow on the trailing edge of the high showed little diurnal variation in speed-averaging about 10 knots.

Figure 3 illustrates these changes.

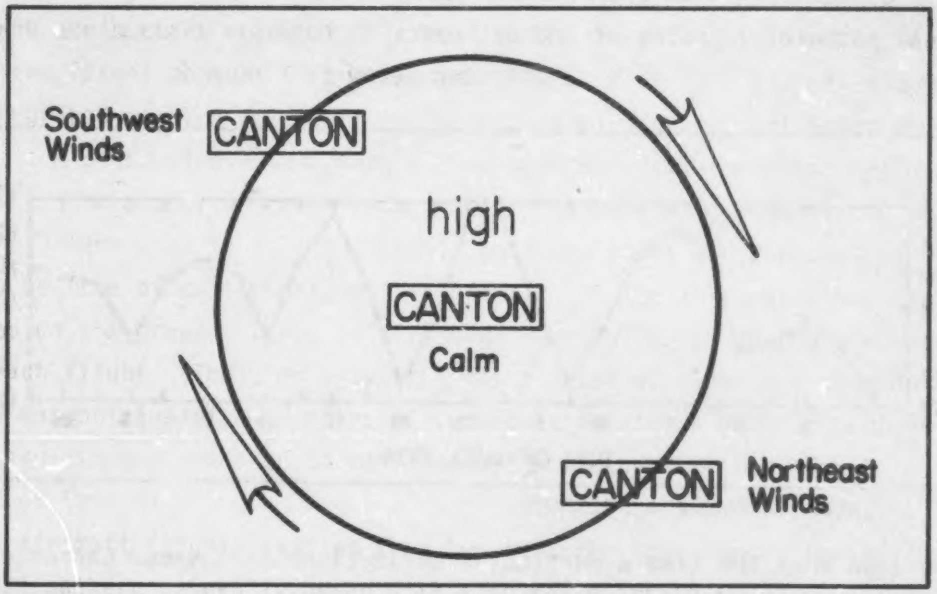


Figure 3. Canton winds in relation to the position of an anticyclone

Figures 4 and 5a - 5e contain additional meteorological information of interest. The former illustrates the relationship between barometric pressure, solar radiation and wind. Each of these parameters will be discussed in greater detail in succeeding sections of this report.

Figure 5a - 5e provide synoptic weather maps showing the position of the high pressure system influencing Canton each day. These are separated into five groups corresponding to five identifiable synoptic situations.

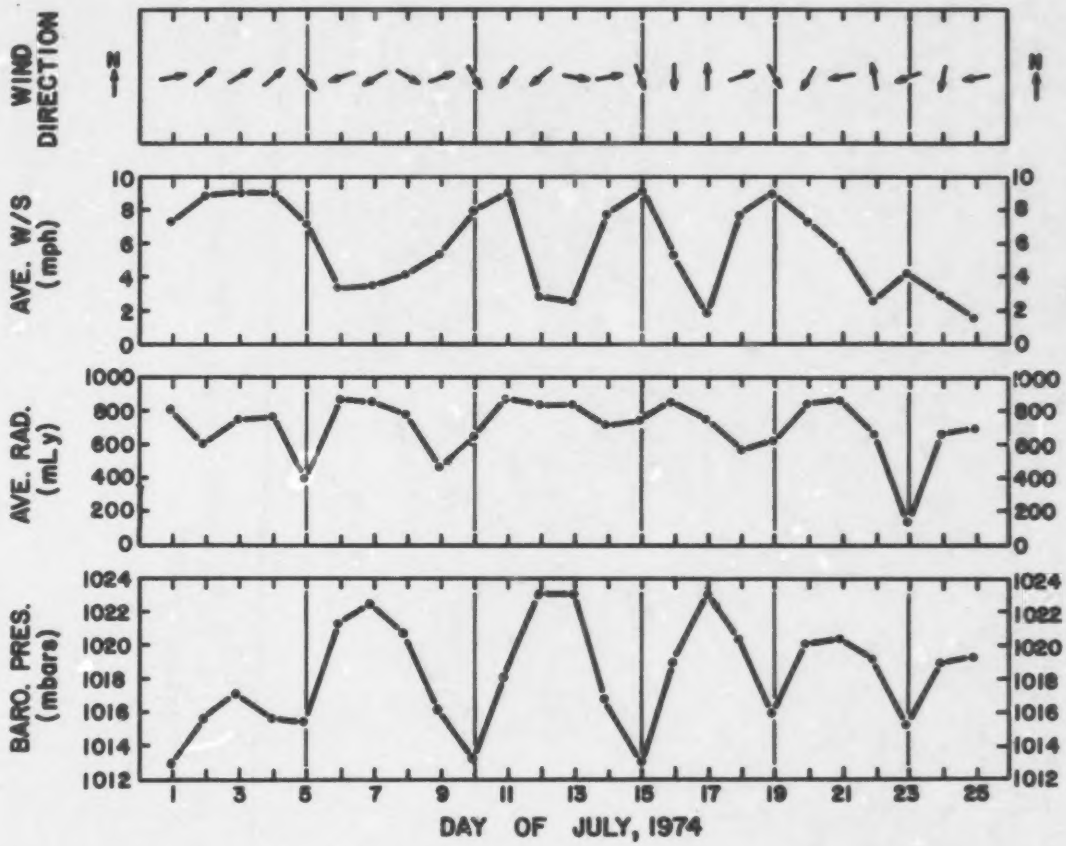
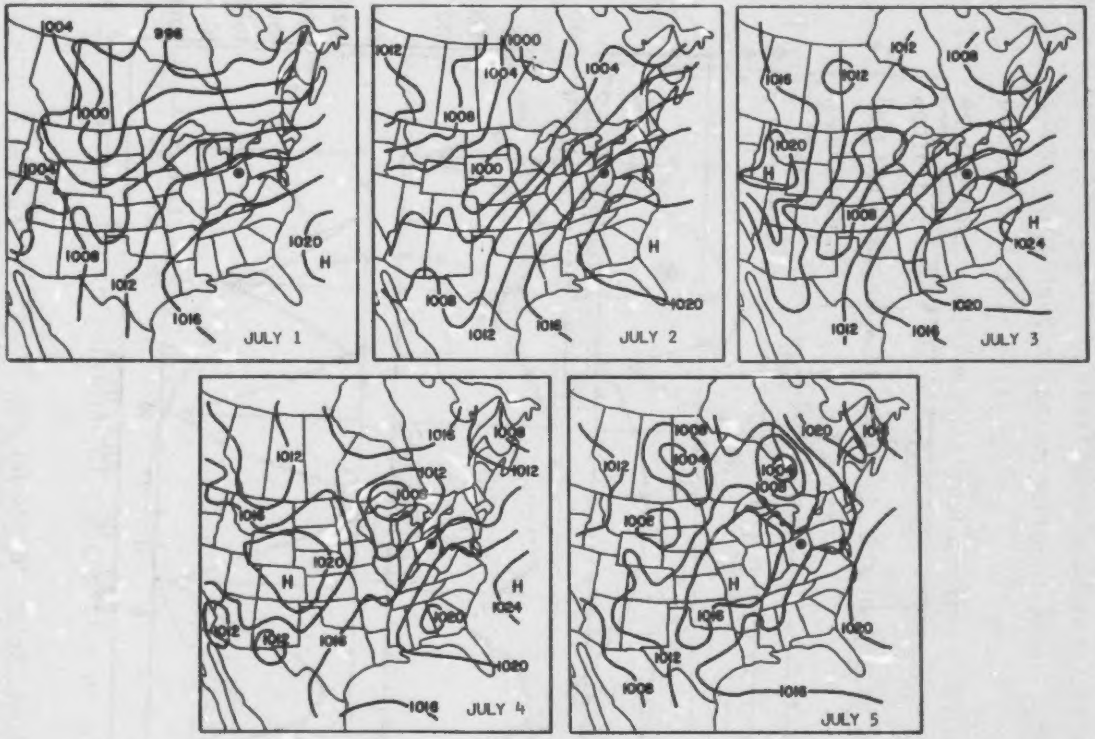


Figure 4. Wind, solar radiation and barometric pressure relationships in Canton during July, 1974.


1004
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JULY 5

Figure 5a. 7:00 am surface pressure maps for July 1-5, 1974 (first high pressure system).

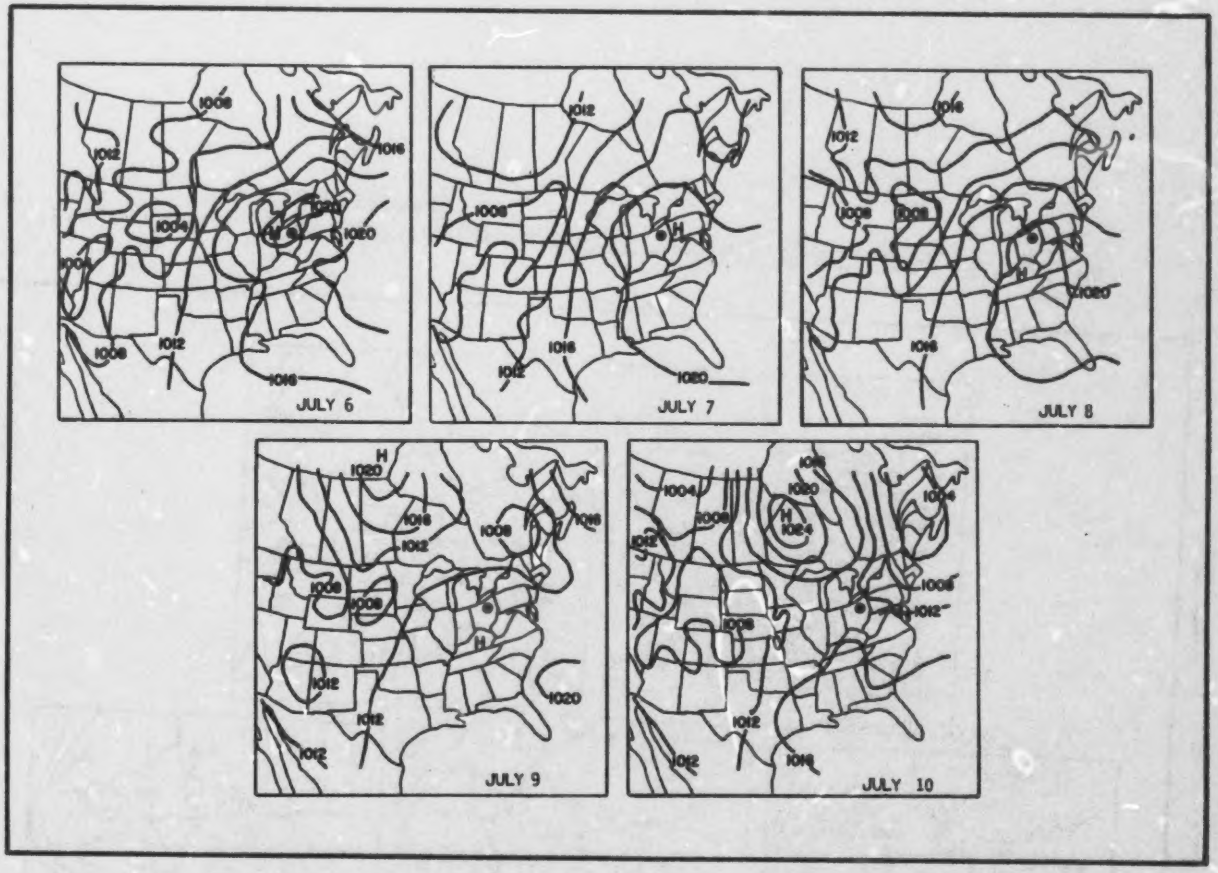
JULY 6
JULY 7
JULY 8
JULY 9
JULY 10

Figure 5b. 7:00 am surface pressure maps for July 6-10, 1974 (second high pressure system).

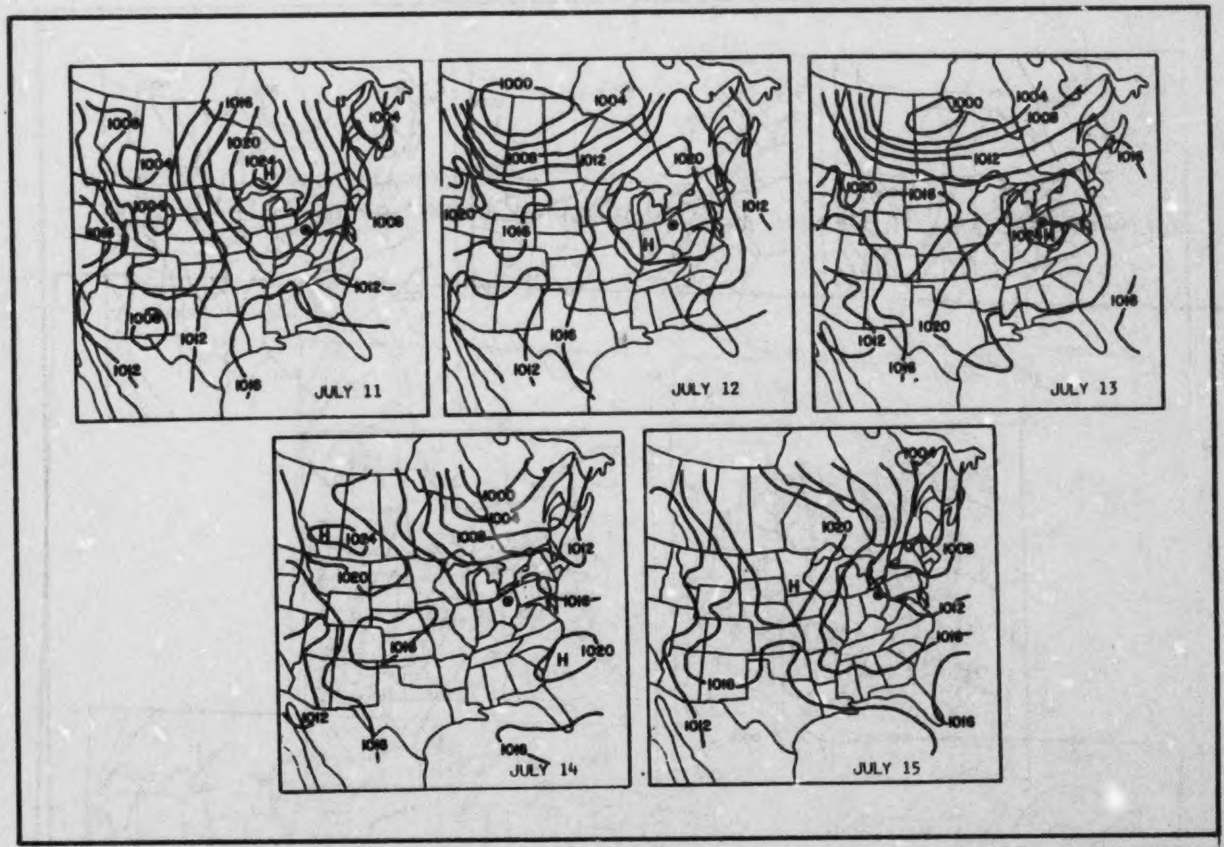
JULY 11
JULY 12
JULY 13
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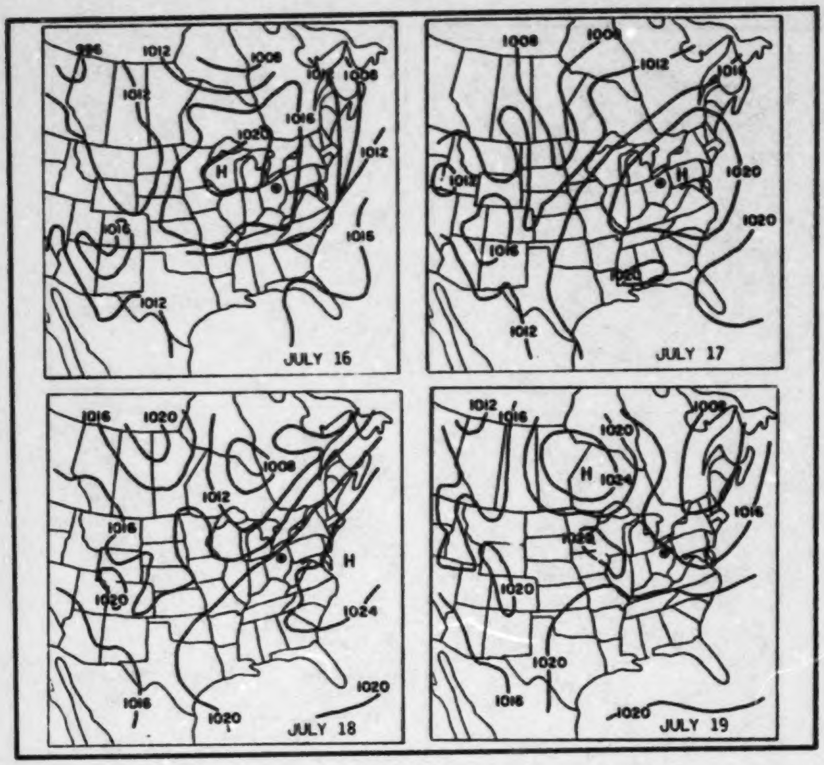
Figure 5c. 7:00 am surface pressure maps for July 11-15, 1974 (third high pressure system).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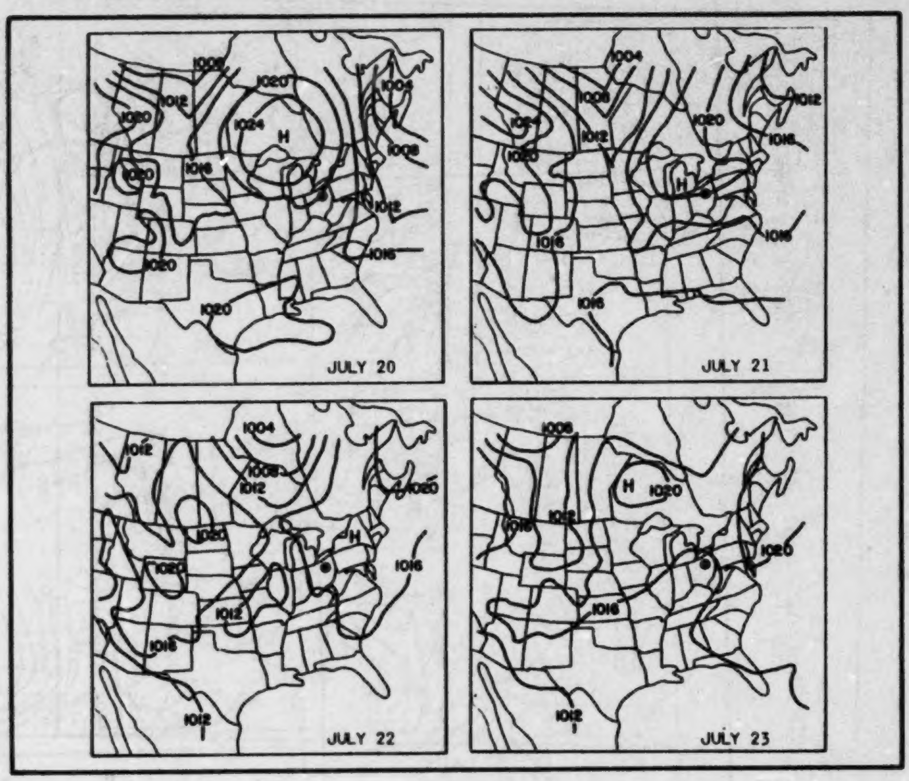
JULY 19

Figure 5d. 7:00 am surface pressure maps for July 16-19, 1974 (fourth high pressure system).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JULY 21
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1020
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1012
JULY 22
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H
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1012
JULY 23

Figure 5e. 7:00 am surface pressure maps for July 20-23, 1974 (fifth high pressure system).

OZONE

A large amount of ozone data was gathered during the 25-day experiment in Canton. It consisted of a continuous record at the ground trailer plus that obtained from aircraft flights over and around the Canton area. Morning and afternoon survey flights at 1000' extended approximately 50 miles upwind and downwind of Canton. In addition, vertical profiles accompanied most of the horizontal surveys. Thus on a typical day we have continuous ozone data at ground level in central Canton, two or more vertical soundings to 6000' over the ground site and morning and afternoon horizontal traverses at 1000' around the Canton area. All this data has been assembled on a daily basis and is presented as such in the Appendix.

It would be needlessly complex to try to summarize all of this information. What will be done for the most part is to look in detail at a typical four day period - July 16-19. This corresponds to the passage of one of the high pressure systems through the Canton area. We believe this period provides a good example of the changes that occur as an anticyclone moves through the area and hence is representative of the several air masses that were observed during the experiment.

With ground measurements it is most informative to consider first the total study period. A recognizable pattern was observed with peak daily ozone and barometric pressure being roughly in phase on a day-to-day basis. Recorded ozone concentrations were very dependent on the geographical position of the high pressure system and its previous track. It is evident in Figure 6 that the lowest peak ozone levels were recorded on the first day of increasing pressure as the incoming high began to influence the Canton area or after a frontal passage brought in a new air mass. Thus July 1, 5, 11, 16 and 20 exhibited relatively low peak ozone levels. Ozone concentrations then increased on each succeeding day reaching a maximum on or shortly after the day of highest barometric pressure. A very noticeable feature of Figure 6 is the fairly regular cyclic pattern that existed throughout July. Oftentimes these high pressure systems will move slowly, bringing about a prolonged period of stagnant weather and leading to a possible air pollution episode.

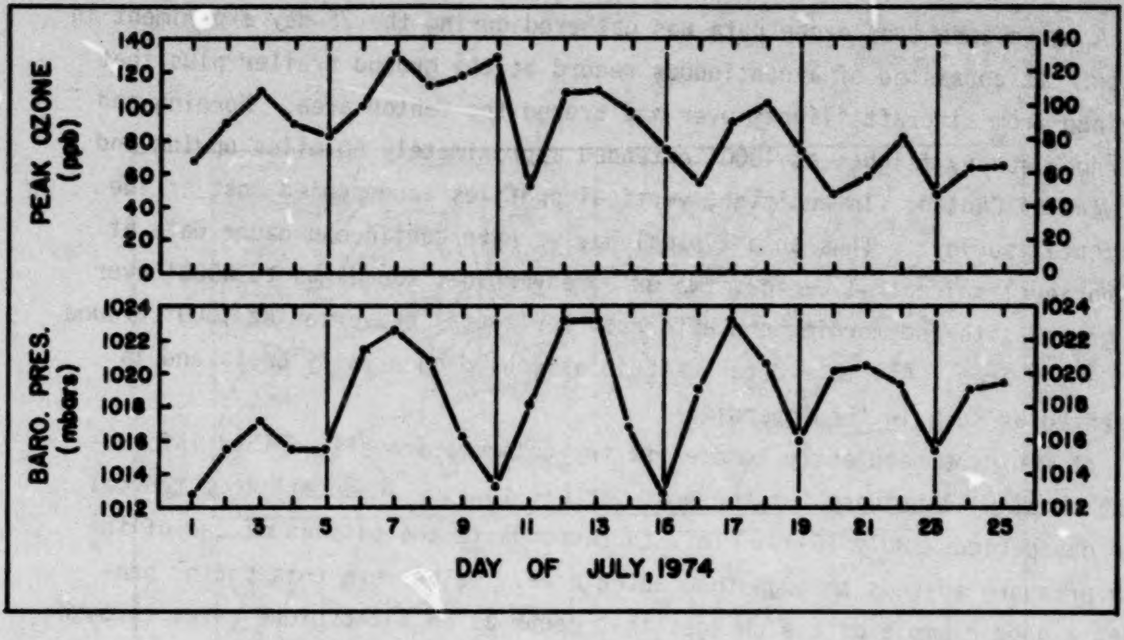


Figure 6. Relationship between peak ozone values and barometric pressure in Canton during July, 1974.

Figure 7 illustrates the ozone and weather changes in more detail by providing a daily summary of continuous ozone changes, wind direction and location of the center of the air mass for the specific period July 16-19. On the 16th the winds were from the north and Canton was on the leading edge of the advancing high. A peak ozone concentration of 55 ppb was measured in this air being carried from the north. By the morning of the 17th Canton was within the central portion of the high and remained so until midmorning on the 18th. Increasing peak ozone levels were recorded during this and the succeeding period of southwesterly winds - reaching 105 ppb on the 18th. Ozone concentration then began to drop on the 19th as the wind shifted and the next high pressure system moved into Ohio from the north.

One particularly noteworthy feature shown in Figure 7 is the late afternoon - early evening time of ozone maximums on the days of highest ozone readings (July 17 and 18.). This was quite characteristic of the entire study period. The reasons for these late afternoon peaks are probably complex; however, it could be partially due to decreased solar radiation and consequently

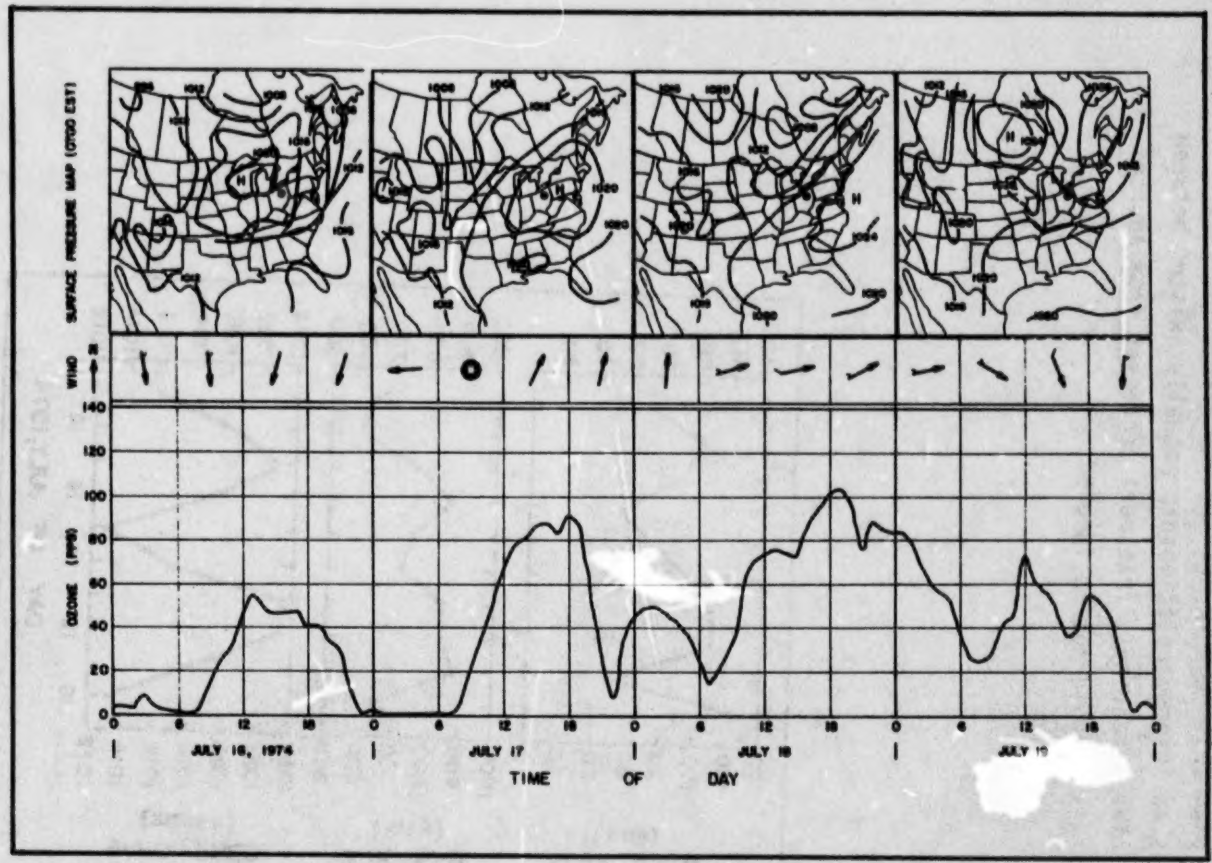


Figure 7. Ozone changes as high pressure system crosses Canton area.

a slowing down of photochemical processes on these days. Maximum solar radiation usually coincided with the first day of increasing pressure and then tailed off as the high continued to move to the southeast. Figure 8 shows that in some cases an inverse relationship actually existed between peak ozone levels and solar intensity. Transport processes from sources beyond the local region also should not be ignored.

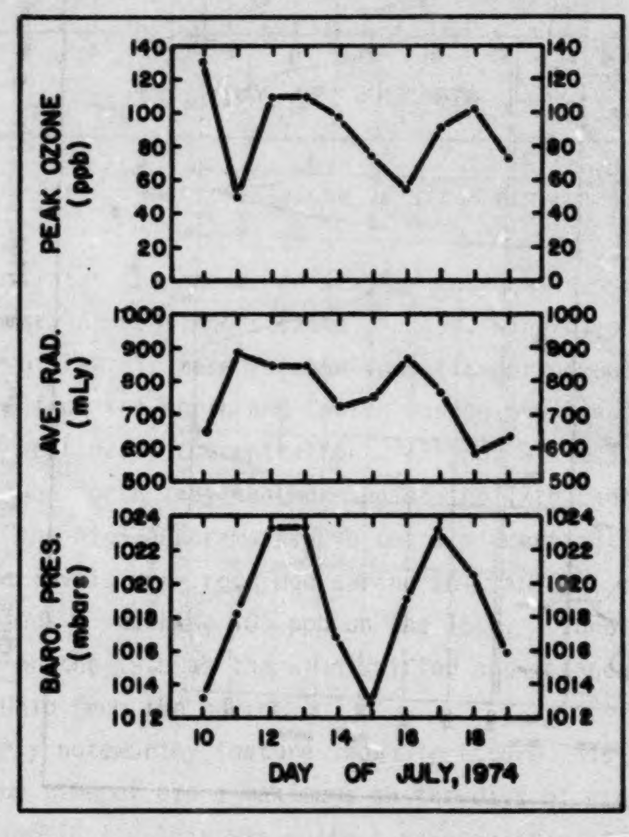


Figure 8. Peak ozone levels, average solar radiation and barometric pressure in Canton during mid-July.

As mentioned previously, aircraft collected ozone data consisted of vertical profiles and horizontal surveys. As with the ground ozone data, upper level ozone concentrations were found to be very dependent on meteorology. A look at changes that occurred during the passage of the July 16-19 high pressure system serves to describe most of the other systems as well.

In addition to providing ozone data, the vertical soundings supplied the upper level temperature structure. Throughout the study period, afternoon mixing depths were generally 3000-5000'. The shallowest mixing coincided with the periods of lowest ventilation. On most mornings a low level radiation inversion (<1000') was present. As is to be expected, these temperature gradients had a profound effect on ozone concentration at various altitudes.

On July 16, as the high pressure system moved into Ohio, morning ozone levels aloft (1000') were in the 30 ppb range. Little difference was observed over an area 40 miles upwind and downwind of Canton. The morning vertical profile showed little change up to 4000' with ozone concentration in the 30-40 ppb region.

By afternoon, ozone readings downwind of Canton had increased to the 60 ppb range, while those upwind averaged about 10 ppb lower. The afternoon vertical sounding shows a variation of 35 to 60 ppb below 6500', with the top of the mixing layer at about 4500'. Thus, as the leading edge of the new high pressure system moved into the Canton vicinity, bringing with it air from the north, ozone concentrations remained relatively low throughout the day at all altitudes, although there was a weak diurnal cycle shown by the data.

As the period of low ventilation began during the early morning hours of the 17th, an upper level subsidence inversion dropped to approximately 3000', trapping below it ozone produced on the 16th. This is illustrated in Figure 9, which clearly shows that peak ozone levels were recorded just below the base of the inversion. The rapid rise in concentration with altitude indicated that no mixing was occurring below the base of the inversion.

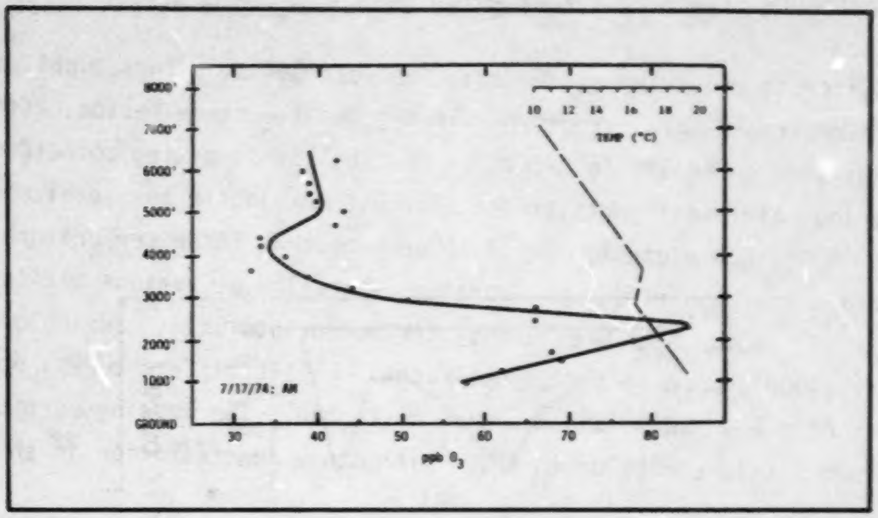
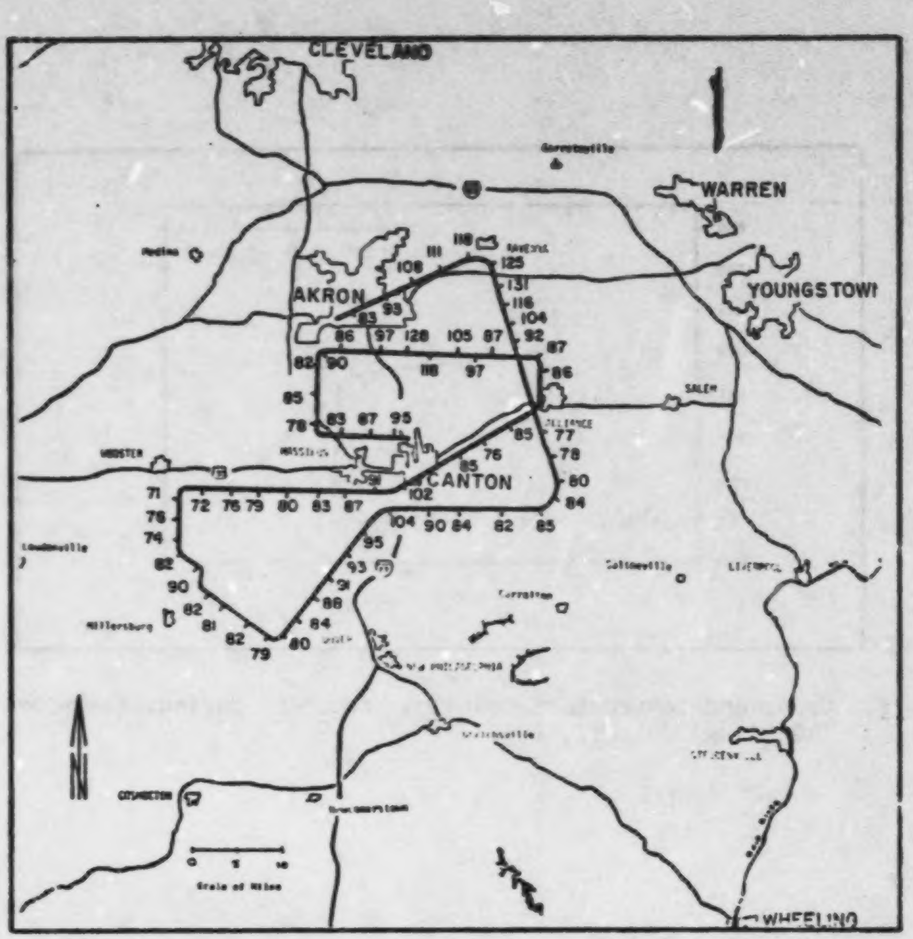


Figure 9. Ozone and temperature soundings recorded during morning flight (~9:50 am) July 17, 1974.

The 1000' horizontal survey flight showed average concentrations of about 60 ppb on the morning of the 17th. This is a two-fold increase from the previous morning. As the period of low ventilation continued, afternoon ozone levels showed a substantial jump. Figure 10 provides data from the afternoon flight and shows that, in the Canton area, concentrations are, for the most part, between 80 and 110 ppb but with some readings as high as 130 ppb.


CLEVELAND
WARREN
YOUNGSTOW
AKRON
CANTON
WHEELING
SALEM
Ravenna
Alliance
Wooster
Massillon
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Coshocton
New Philadelphia
Carrollton
Steubenville
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Figure 10. Ozone concentrations (ppb) at points along afternoon flight path on July 17, 1974.

By midafternoon on July 17, daytime heating had increased the mixing depth to about 4000', as shown in Figure 11. As a result, the ozone concentration is fairly constant up to the base of the subsidence inversion and then drops off rapidly at higher altitudes. The type of ozone - temperature - altitude relationship seen in Figure 11 is typical of those observed on most afternoons.

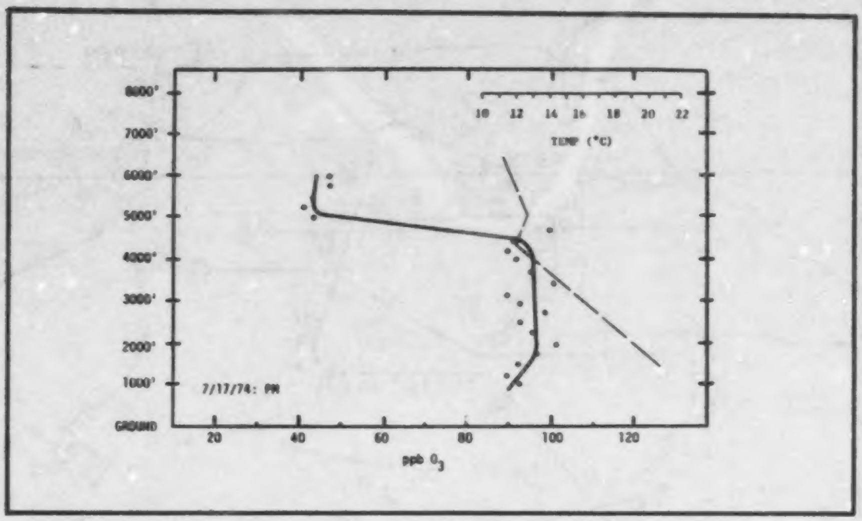

Figure 11. Ozone and temperature soundings recorded during afternoon flight (~2:30 pm) July 17, 1974.

A different type of ozone-altitude behavior was observed on the morning of the 18th. As illustrated in Figure 12, a nearly constant ozone concentration existed up to the base of the inversion, then a large increase was recorded within the stable layer. This ozone rich layer at ~3000' could be followed for a distance of 20 miles from Canton. An explanation for this stratification seems to be that as the inversion reformed at a lower altitude during the nighttime hours, it trapped above its base high ozone levels produced the day before. Efficient mixing up to the base of the stable layer is indicated by the fairly constant ozone levels measured throughout that lower region. This probably means that a low level radiation inversion was absent for a good portion of the nighttime hours. Support for this contention is gained from Figure 7, which shows an unusual ground level nighttime ozone build-up - undoubtedly the result of mixing with ozone rich air aloft.

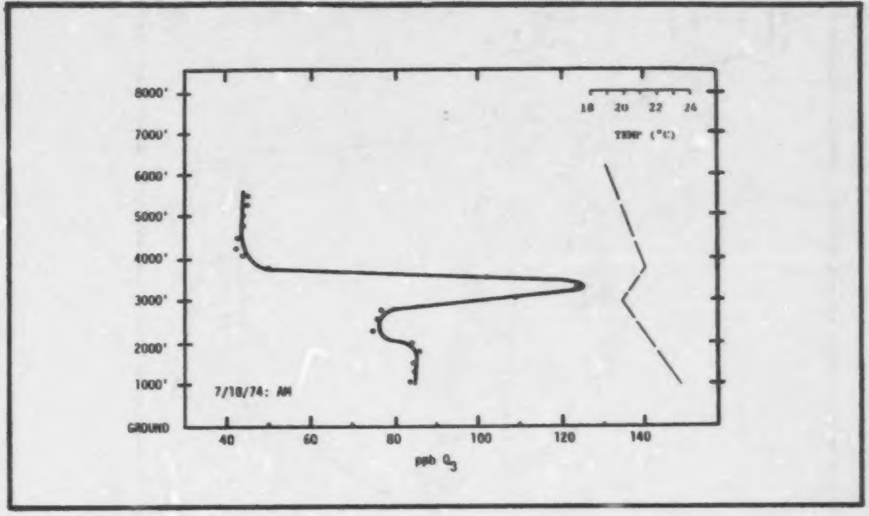

Figure 12. Ozone and temperature soundings recorded during morning flight (~9:30 am) July 18, 1974.

The survey flight on the morning of the 18th (Figure 13) showed increased ozone levels compared to the previous morning. Where the downwind concentrations averaged 65 ppb on the 17th, they were up to 85 on the 18th.

Between the morning and afternoon flights on the 18th meteorological conditions changed. The period of low ventilation ended with Canton now feeling the effects of the trailing edge of the high and the approach of a frontal trough. Winds were from the southwest at approximately 12 mph throughout the afternoon and evening hours. With the increased air movement, a noticeable decrease in afternoon ozone concentrations was observed. Figure 13 shows that whereas the average morning downwind concentration was about 85 ppb, the corresponding afternoon data showed a drop of about 10 ppb. Also the afternoon upwind measurements were higher than those on the downwind loop.

This influx of ozone into Canton is also reflected by the ground measured ozone values during late afternoon and evening hours. Returning once again to

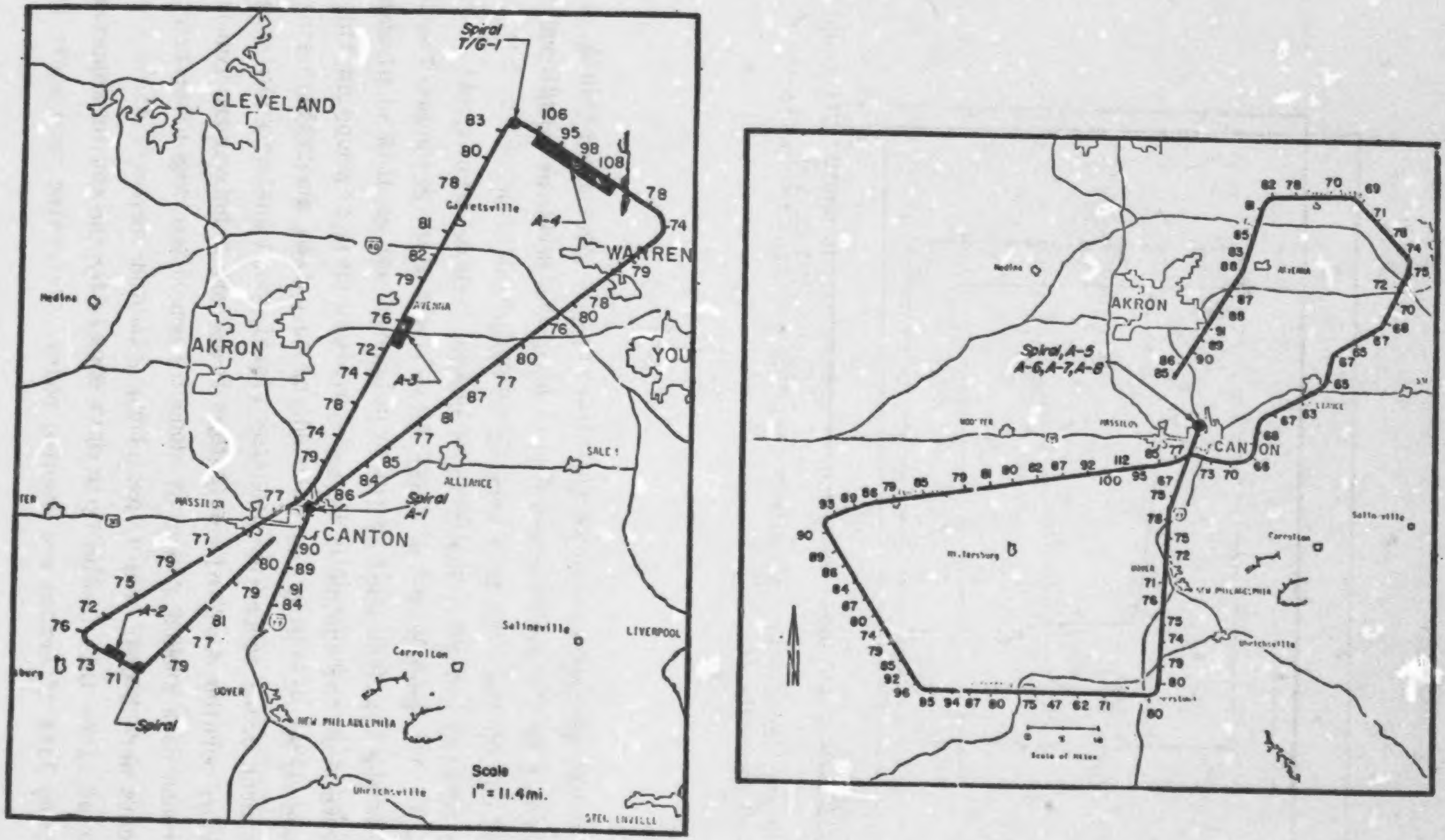
CLEVELAND
AKRON
CANTON
WARREN
Spiral T/G-1
A-4
A-3
Spiral A-1
A-2
Spiral
Medina
Massillon
Alliance
Garrettsville
Ravenna
Salineville
Liverpool
Carrollton
Dover
New Philadelphia
Uhrichsville
Scale 1" = 11.4mi.
Spiral, A-5 A-6, A-7, A-8
Scale of Miles

Figure 13. Ozone survey flights on July 18, 1974.

Figure 7 it is seen that after sunset on the 18th, the ozone concentration didn't drop off as usual. Values greater than 80 ppb were recorded past midnight.

As the wind shifted to the northwest on the morning of the 19th (signaling the approach of a weak trough) ozone concentrations began to decrease. July 19th consisted of a transition day in which a broad trough was passing and the old high pressure system was being displaced by a new one from the northwest. Peak ozone concentrations both on the ground and aloft were lower than on the 18th. The cycle began anew on the 20th with northerly winds and ozone concentrations comparable to those measured on the first day (16th) of the previous cycle.

This completes the description of ozone behavior in relation to these midwest weather patterns. Certainly some differences exist between the air mass just described and others during the July 1-25 period, however the general pattern for all the observed anticyclones was similar to that outlined.

OZONE TRANSPORT MODEL

From the observations described in preceding paragraphs it appears possible to explain ozone behavior during the passage of a high in terms of a model consisting of three distinct phases. During two of these stages, long range transport serves as a source of the oxidant while ozone build-up in the other is due to localized photochemical processes.

Northerly winds associated with the leading edge of the high pressure system control ozone concentrations during the first phase. This is a period of good atmospheric mixing in which ozone and/or ozone precursors may be carried into the Canton area and blend with local emissions. Afternoon ozone levels are lowest during this first stage of the cycle and may in part be due to stratospheric or background sources.

Phase two is experienced when the high is centered over Ohio. A stagnation period results during which high afternoon ozone concentrations develop. This ozone production is due primarily to local photochemical mechanisms.

Phase three results as the area comes under the influence of the trailing edge of the high. The associated southwest winds clear out locally generated pollutants and bring in ozone and its precursors produced in source areas upwind. This period is characterized by long range transport of ozone produced as a result of anthropogenic emissions incorporated into the air mass. Figure 14 provides a graphical sketch of the important features of the model.

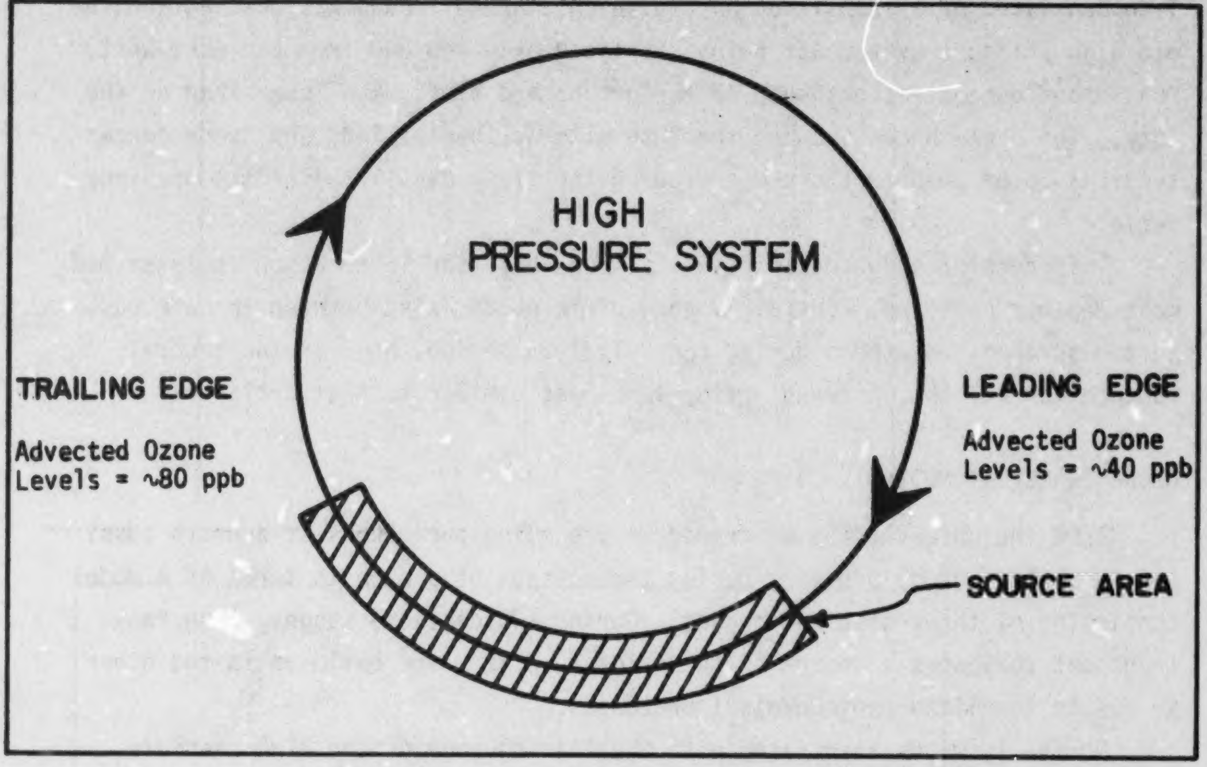
HIGH
PRESSURE SYSTEM
TRAILING EDGE
Advected Ozone Levels = ~80 ppb
LEADING EDGE
Advected Ozone Levels = ~40 ppb
SOURCE AREA

Figure 14. Ozone behavior within a high pressure air mass.

Support for this model comes from the data presented previously, plus its intuitively reasonable features. The low ozone levels associated with the leading edge of the high are not unexpected, since prior to reaching Canton the air mass has spent very little time over highly populated areas. However, as it passes over industrialized areas in the United States, ozone and precursors necessary for ozone production are incorporated into the air mass. The fact that ozone persists in the air mass and is transported as such is supported by the high levels recorded during nighttime hours with strong southwesterly winds. A good example of this phenomenon occurred on July 18 (see Fig. 7). The persistant southwesterly flow began about 6 AM, signalling the end of the stagnation period. Ozone levels increased throughout the day even though solar intensity was relatively low. As the sun set, a small decrease in ozone concentration occurred but not nearly that seen during other stages of the cycle. Levels above 80 ppb persisted past midnight and then began to drop off as the wind shifted, indicating the approach of a new air mass.

HYDROCARBONS

Samples for light hydrocarbon analysis were collected at ground sites within the city and by aircraft over Canton. Figure 15 shows a gas chromatogram typical of those obtained from ground collected bag samples. The named compounds are ones for which concentrations will be provided. Identification is based on retention times. The GC system exhibited excellent reproducibility from run to run, and this, coupled with good resolution, provided a high confidence level for both identification and quantitation. Minor interferences are possible in the C_5 and C_6 ranges, but for the lower molecular weight region all components are clearly resolved. Oxygenated species do not interfere, since at the temperatures employed they pass through the column very slowly. Even the volatile compound acetone possesses a retention time considerably longer than hexane.

Sampling in the close vicinity of three Canton area hydrocarbon sources provided a profile of their light hydrocarbon emissions. Table 1 lists the identity and concentration of light hydrocarbons associated with oil fields, a refinery, and automobiles. The numbers provided in Table 1 need not be normalized to see that the oil field sample is low in unsaturates and very rich in ethane and propane. The refinery sample, which was collected near the bordering fenceline, consists of predominantly C_4 and C_5 saturated hydrocarbons and is low in ethylene and acetylene. The automotive sample resembles that of the refinery except for the proportionately larger amounts of ethylene, acetylene and propene. The contribution of these sources to the hydrocarbon burden in Canton will be mentioned in succeeding paragraphs.

Ground sampling consisted of three-hour integrated samples collected twice a day at three didfferent sites; downtown, Malone College, and North Canton. Data for the downtown and Malone sites are provided in Tables 2 and 3. Light hydrocarbon levels at the third site (North Canton) were nearly identical to those reported for Malone College and thus are not included.

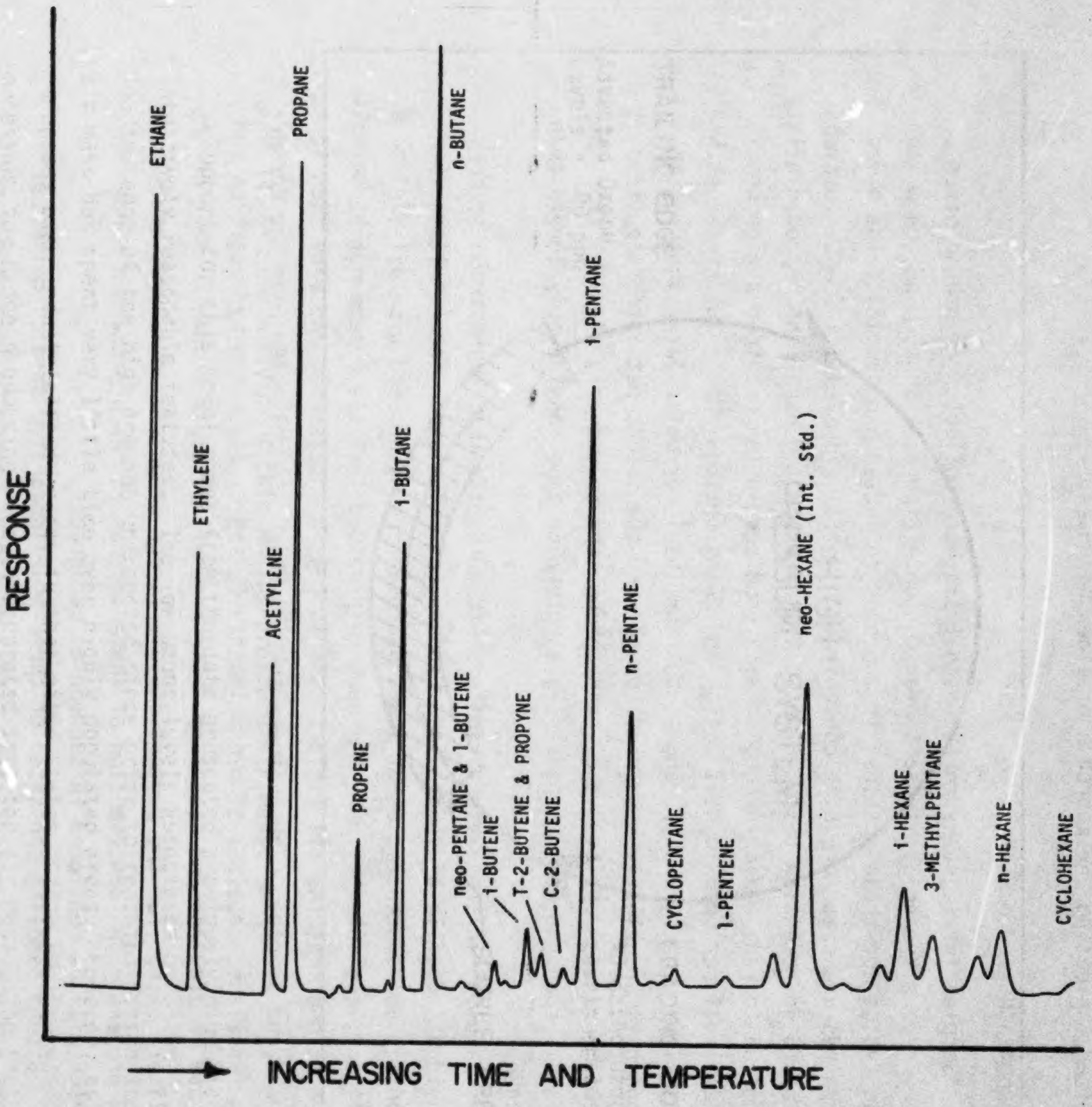

Figure 15. Chromatogram of sample collected at Malone College site on July 8, 1974 (6:00-9:00 am).

TABLE 1. LIGHT HYDROCARBON CONCENTRATIONS ($\mu g/m^3$) ASSOCIATED WITH VARIOUS SOURCES IN THE CANTON AREA

	Oil Field	Refinery	Automobile[†]
Ethane	276	25.0	32.5
Ethylene	4.5	6.0	51.0
Acetylene	2.0	3.0	52.0
Propane	163	61.0	29.5
Propene	1.5	4.0	27.5
i-Butane	34.5	427	120
n-Butane	69.0	656	288
neo-Pentane 1-Butene	1.5	63.0	10.5
i-Butene	.5	40.0	13.5
T-2-Butene Propyne	*	74.0	28.0
C-2-Butene	*	59.0	16.5
i-Pentane	30.0	564	423
n-Pentane	26.0	248	117
Cyclopentane	1.0	19.5	15.5
1-Pentene	.5	88.0	13.0
i-Hexane	7.0	93.0	122
3-Methylpentane	3.5	35.5	58.0
n-Hexane	13.0	78.0	90.0
Cyclohexane	4.5	30.0	14.5

* = Less than .5 $\mu g/m^3$.

[†] Enclosed parking lot sample.

TABLE 2. LIGHT HYDROCARBON CONCENTRATIONS ($\mu g/m^3$) IN CANTON, OHIO; DOWNTOWN SITE

I. 6:00-9:00 AM	7/2	7/3	7/4	7/5	7/8	7/9	7/10	7/11	7/12	7/15	7/16	7/17	7/18	7/19	AVE
Ethane	42.0	20.5	16.0	27.0	125	47.0	25.0	9.0	23.0	29.0	18.5	57.0	47.0	11.5	35.5
Ethylene	10.0	12.0	5.5	17.0	41.0	20.0	22.5	8.0	14.0	26.0	23.0	22.0	17.0	17.0	18.0
Acetylene	7.0	8.5	2.0	10.5	46.5	15.0	18.0	5.5	12.5	23.5	23.5	19.5	14.0	13.5	15.5
Propane	27.0	14.5	12.0	20.5	90.5	31.0	20.0	5.5	16.0	17.5	8.5	38.5	27.5	10.0	24.0
Propene	4.5	5.5	1.5	7.0	19.0	10.0	8.5	3.0	5.5	10.5	9.5	9.0	8.5	6.0	7.5
i-Butane	15.0	12.0	7.5	18.5	79.0	37.0	25.5	4.5	9.5	19.5	14.5	30.0	22.5	21.5	22.5
n-Butane	33.0	25.0	16.0	43.5	159	72.0	60.5	9.5	23.0	45.5	36.0	66.0	49.0	44.5	49.0
1-Butene	1.5	3.0	1.5	8.0	8.0	5.0	6.0	1.5	3.0	5.0	3.0	5.0	3.5	1.5	4.0
i-Butene	2.0	2.5	1.0	8.0	8.5	4.5	6.0	1.5	2.0	6.5	4.5	4.0	5.5	2.5	4.0
T-2-Butene	2.0	2.0	1.0	7.5	11.0	5.0	7.0	1.5	2.0	9.0	14.5	6.5	5.5	3.5	5.5
C-2-Butene	*	1.0	.5	4.5	6.0	3.0	4.5	1.0	1.0	4.5	3.0	3.0	4.0	2.0	2.5
i-Pentane	27.0	27.5	19.0	51.0	155	84.0	77.0	11.0	24.0	59.5	49.5	63.5	55.5	51.5	54.0
n-Pentane	13.0	10.5	7.0	21.5	60.5	31.5	28.0	5.0	10.5	23.0	17.0	25.5	23.5	17.0	21.0
Cyclopentane	2.0	1.5	1.0	3.5	6.0	4.0	4.0	1.0	1.5	4.0	3.0	3.0	2.0	1.0	2.5
1-Pentene	1.0	1.0	*	1.0	3.0	2.0	2.0	*	1.0	.5		*	1.0	1.0	1.0
i-Hexane	9.0	8.0	6.0	17.0	43.0	24.0	16.5	2.5	5.5	17.0	18.5	15.5	11.5	18.5	15.0
3-Methylpentane	5.5	6.0	4.0	13.0	32.0	17.5	10.5	2.0	4.5	9.0	1 4.0	8.5	8.5	14.5	10.5
n-Hexane	6.5	4.0	3.5	8.5	27.0	12.5	15.0	3.0	6.0	13.0	17.0	12.5	13.5	14.5	11.0
Cyclohexane	1.0	1.5	*		7.5	4.0	3.0	*	1.5	3.5	4.0	3.5	2.5		2.5
Total $\mu g/m^3$	209	167	105	288	928	429	360	75.0	166	326	282	393	322	251	308
NMTHC (ppm)	.7	.4	.5	.7	2.5	1.2	.4	.4	.6	1.2	1.1	1.2	1.1	1.8	1.0
CO (ppm)	1.9	1.9	1.3	2.4	6.2	3.2	1.5	1.6	2.8	4.0	3.8	3.3	3.2	3.3	2.9
CH_4 (ppm)	2.3	1.9	1.9	2.0	3.6	2.3	1.9	1.7	1.9	2.0	2.0	2.4	2.4	1.8	2.2
NO_x (ppb)	73	59	31	77	185	89	64	31	77	135	135	140	97	71	90

TABLE 2. Continued

II. 1:00-4:00 PM	7/1	7/3	7/4	7/5	7/8	7/9	7/10	7/11	7/12	7/15	7/16	7/17	7/18	7/19	AVE
Ethane	8.0	14.0	11.0	13.0	11.0	12.5	13.5	7.5	9.0	9.5	7.0	15.0	12.5	8.5	11.0
Ethylene	8.0	15.5	5.0	17.0	13.5	14.5	15.5	8.5	12.0	15.0	6.0	7.0	8.0	10.0	11.0
Acetylene	5.5	12.0	2.0	15.0	12.0	11.5	13.5	7.0	9.5	12.5	10.0	5.0	5.5	12.5	9.5
Propane	6.5	12.0	8.0	9.5	8.5	12.0	10.5	4.5	6.5	5.5	3.5	10.0	6.0	4.5	7.5
Propene	4.0	6.0	1.0	6.5	4.5	6.0	4.5	3.0	4.5	5.0	3.0	2.5	2.5	5.0	4.0
i-Butane	16.0	19.0	5.5	20.0	43.0	29.0	22.0	8.0	16.5	14.5	11.5	16.0	13.5	15.0	18.0
n-Butane	34.0	41.5	11.5	46.0	88.5	62.5	49.0	19.0	40.0	36.0	29.0	35.0	28.5	36.0	40.0
1-Butene	2.0	4.5	1.0	3.5	4.5	4.0	3.0	2.0	3.0	1.5	1.0	.5	1.0	1.5	2.5
i-Butene	2.0	6.0	1.0	3.5	4.0	2.5	2.5	2.0	1.5	1.5	1.0	.5	1.0	2.0	2.0
T-2-Butene	1.5	3.5	*	3.0	1.5	1.5	1.5	1.5	3.5	2.5	1.5	1.0	.5	3.0	2.0
C-2-Butene	1.0	2.0	*	1.5	1.0	.5	.5	1.0	1.5	.5	*	.5	*	1.5	1.0
i-Pentane	35.5	42.5	12.0	55.0	100	68.0	55.5	21.0	41.5	40.5	34.5	37.0	36.0	45.0	44.5
n-Pentane	12.0	16.5	5.0	18.0	27.0	22.5	18.5	8.0	13.5	14.0	11.5	12.0	11.5	15.0	14.5
Cyclopentane	1.5	1.0	.5	2.5	3.5	2.0		1.5	2.0	2.5	1.5	.5	1.5	2.0	1.5
1-Pentene	1.0	1.0	*	1.5	2.5	1.5		.5	*	1.0	1.5	*	1.0	.5	1.0
i-Hexane	10.0	7.5	3.5	15.5	32.0	21.0	17.5	5.0	6.5	12.5	9.0	4.5	12.0	15.0	12.5
3-Methylpentane	7.0	5.5	2.0	9.5	22.0	14.0	12.0	3.0	4.5	8.5	7.0	2.0	8.0	11.0	8.5
n-Hexane	6.0	8.0	1.5	8.5	56.0	18.5	16.5	6.0	6.0	8.0	6.5	3.0	14.0	11.5	12.0
Cyclohexane	1.5	1.5		2.0	4.0		1.5	*	1.0	1.5		*			1.5
Total μg/m^3	163	220	70.5	251	439	304	258	109	183	193	145	152	163	200	205
NMTHC (ppm)	.7	.7	.1	.8	1.3	.9	.9	.5	.7	.7	.6	.6	.7	.8	.7
CO (ppm)	1.8	2.4	1.0	3.6	3.0	2.7	2.8	2.0	2.3	3.0	2.4	1.7	1.8	3.3	2.4
CH_4 (ppm)	1.6	1.8	1.8	1.8	1.7	1.7	1.8	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.7
NO_x (ppb)	27	38	23	68	38	48	59	30	35	48	39	28	30	55	40

TABLE 3. LIGHT HYDROCARBON CONCENTRATIONS ($\mu g/m^3$) IN CANTON, OHIO; MALONE COLLEGE SITE

I. 6:00-9:00 AM	7/1	7/2	7/3	7/4	7/5	7/6	7/7	7/8	7/9	7/10	7/11	7/12	7/13	7/14	7/15	7/16	7/17	7/18	7/19	7/20
Ethane	45	31	19	18	19	16	38	71	43	19	7	17	72	19	18	15	27	34	12	8
Ethylene			6	5	7	6	14	19	14	8	4	10	10	6	10	8	18	10	6	3
Acetylene	16	6	3	1	5	2	8	16	10	5	2	7	8	3	6	5	14	7	3	1
Propane	31	20	18	18	12	8	20	43	28	10	4	8		11	11	7	18	18	7	5
Propene	9	4	5	3	3	1	5	8	6	2	1	3	2	1	4	3	6	4	1	1
i-Butane	32	15	16	15	5	3	8	24	17	5	2	4	17	12	6	5	10	8	5	1
n-Butane	71	30	38	34	12	7	20	57	39	12	5	10	37	24	14	12	24	18	10	4
1-Butene	6	3	2	3	1	*	1	1	3		*	1	1		1	1	1	1	*	
i-Butene	6	2	2	2	2	*	4	6	3	1	1	1	1		2	1	2	2	*	1
T-2-Butene	6	2	2	1	1	*	2	4	3	1	1	2	1	*	2		3	2		*
C-2-Butene	4	1	*	1		*	1	2	1	*	*	*		*			1	1		*
i-Pentane	73	25	36	29	12	6	21	52	46	11	6	11	30	21	14	13	23	18	11	3
n-Pentane	34	13	21	19	6	3	11	26	26	5	2	5	15	11	7	6	12	9	4	1
Cyclopentane	3	1	3	1		*	1	2	2	1	*	*		*	1	1	1	1		*
1-Pentene	2		1	1		*	*	1	1	*	*	*			*	*				*
i-Hexane	18	7	8	7	3	2	8	18	14	3	1	5	8	6	5	5	9		3	*
3-Methylpentane	15	6	4	5	2	1	4	11	10	3	1	2	7	5	3	3	6	3	4	
n-Hexane	14	3	7	3	4	3	5	12	7	3	3	3	8	6	8	10	5	4	2	1
Cyclohexane	3	1	1	1		1	1	2	3	*	*			*	1	1	1		*	*
Total $\mu g/m^3$	388	170	192	167	94	59	172	375	276	89	40	89	217	125	113	96	181	140	68	29
NMTHC (ppm)	1.1	.6	.4	.6	.2	.3	.6	1.1	.8	1.3	.3	.4	.8	.4	.7	.4	.6			.4
CO (ppm)	2.9	1.6	1.3	1.2	1.2	1.0	2.0	3.2	3.2	3.4	1.1	2.3	1.9	1.2	1.6	1.4	2.5		1.3	.9
CH_4 (ppm)	2.3	2.0	1.9	1.8	1.9	1.8	2.2	2.7	2.2	1.9	1.6	1.9	2.6	1.7	1.8	1.9	2.7		1.8	1.7
NO_x (ppb)	123	64	40		53	30	89	120	74	94	33	96	60	24	72	72	123		41	27

TABLE 3. Continued

II. 1:00-4:00 PM	7/1	7/2	7/3	7/4	7/5	7/6	7/7	7/8	7/9	7/10	7/11	7/12	7/13	7/14	7/15	7/16	7/17	7/18	7/19
Ethane	6	14	9	10	7	7	14	10	7	7	5	4	7	6	8	5	15	9	7
Ethylene	11	4	4	3	7	3	7	3	5	3	4	2	3	3	4	3	3	3	3
Acetylene	1	2	2	1	4	1	2	2	1	1	2	1	2	1	2	1	1	1	1
Propane	3	9	8	8	4	3	8	5	4	6	2	3	5	5	4	2	7	5	4
Propene		2	1	1	1	1	2	1	1	1	1		*		1				2
i-Butane	2	4	3	4	4	1	5	3	2	7	1	2	2	5	2	1	4	3	4
n-Butane	5	9	9	10	9	3	12	6	5	10	2	3	6	6	6	3	8	7	8
1-Butene	*	2	1	1	*	*	1		*	*	*	*	*	*	1	*	*	*	1
i-Butene		1	1	1			1	2		*	*	*	*	*	1	*		*	2
T-2-Butene	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	
C-2-Butene	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
i-Pentane	4	7	6	8	10	3	12	5	4	9	2	3	4	4	5	3	7	6	7
n-Pentane	1	4	3	5	4	1	5	2	2	4	1	1	2	2	3	1	3	3	3
Cyclopentane	*		*			*	2	*	*	*	*	*	*	*	*	*	*	*	1
1-Pentane	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
i-Hexane	1	2	1	3	3	1	3	1		2		1	1	*	1	*	3	2	1
3-Methylpentane	1	1	1	1	2	*	2		*	1		*	1	*	*		1	2	1
n-Hexane	1	1	1	1	2		2	1		2	1	*	*	*	1	1	1	1	1
Cyclohexane	*		*		*	*	*	*		*	*	*	*	*	*	*	*	*	*
Total µg/m³	36	62	50	57	57	24	78	41	31	53	21	20	33	32	39	20	53	42	46
NMTHC (ppm)	.3	.3	.1	.1	.1	.2	.4	.3	.2	.4	.2	.2	.2	.2	.2	.1		.3	.2
CO (ppm)	.9	1.1	1.0	.9	1.4	1.0	1.3	1.0	1.0	1.2	.9	.9	1.0	1.0	1.4	.9		1.0	1.2
CH_4 (ppm)	1.6	1.8	1.7	1.8	1.7	1.6	1.7	1.6	1.6	1.7	1.6	1.5	1.6	1.6	1.6	1.6		1.7	1.6
NO_x (ppb)	16	24	20	23	24	16	33	25	30	42	21	14	20	22	20	20		19	25

Notable features in Table 2 and 3 include the following:

1) Light hydrocarbon levels are highest in the downtown area. 6:00 - 9:00 AM totals are two to three times higher at the downtown site than at the Malone College site. The difference is even larger during the afternoon hours (1-4 PM) with approximately a five times higher light hydrocarbon burden recorded in the downtown area.
2) Afternoon hydrocarbon totals at Malone College (Table 3) are considerably lower than those recorded in the morning. On July 1 and 8 there is nearly a 10-fold difference with the average being about a factor of four. However, this was not the case downtown as can be seen in Table 2. On some days such as July 3 and 11, the afternoon total was actually higher. The average difference in hydrocarbon levels between morning and afternoon at the downtown site was only 1.5.
3) Unusually high levels of ethane were recorded on several mornings. This is especially evident on the mornings of July 8, 13 and 18 at the Malone College site. Oil fields in the Canton vicinity are the most likely source of this excess ethane.
4) The composition of many samples collected at the downtown site resemble very closely the automobile sample listed in Table 1. A good example is the ambient air sample collected at the downtown site on the afternoon of July 8. As shown in Table 4, the ratios of various hydrocarbons to butane in that afternoon sample are nearly identical with those in the automobile sample.

TABLE 4. LIGHT HYDROCARBON/n-BUTANE RATIOS IN AUTO EXHAUST AND DOWNTOWN SAMPLES, CANTON, OHIO, JULY, 1974.

	C_2H_6	C_2H_4	C_2H_2	C_3H_8	n-C_4H_{10}	i-C_5H_{12}	n-C_5H_{12}
Auto Emission (from Table 1)	.11	.18	.18	.10	1.0	1.4	.40
Downtown Sample 1-4 PM 7/8/74 (from Table 2)	.12	.15	.14	.10	1.0	1.1	.30

These data suggest that hydrocarbons measured at the downtown site result primarily from auto emissions, while at the Malone College site hydrocarbons from sources other than the automobile are recognizable.

It is interesting to examine hydrocarbon behavior in relation to meteorological changes. It can be clearly seen in Table 3 that light hydrocarbon concentrations are lowest on July 6, 11, 16 and 20. On all of these days, Canton was experiencing northerly winds and from an examination of the synoptic weather maps was on the leading edge of an advancing high pressure system. It should be recalled that these were also the days of lowest ozone build-up.

Table 5, which includes both ground and aircraft collected data, further illustrates the tie between meteorology and hydrocarbon concentration. This table shows afternoon hydrocarbon levels recorded on the ground and aloft over the Malone College site. As expected, hydrocarbon levels were highest during the period of low ventilation, July 17, when locally emitted pollutants were not readily dispersed. During the other two days shown in Table 5 (July 16 and 18), concentrations were lower. However, comparing July 16 and 18 brings out the fact that there was about a two-fold difference in hydrocarbon concentration between the leading and trailing edge of the high pressure system. This is about the same behavior that was observed with ozone. Afternoon wind speeds (12 mph) and mixing depths on July 16 and 18 were about the same, so the difference in hydrocarbon levels can't be ascribed to dilution factors. Rather, it appears that the difference is best explained in a manner similar to that for ozone; namely, air advected into the Canton vicinity from the southwest has spent more time over industrialized areas, and consequently, it contains a larger pollutant burden.

TABLE 5

AFTERNOON LIGHT HYDROCARBON CONCENTRATIONS AT GROUND LEVEL AND ALOFT UNDER VARIOUS METEOROLOGICAL CONDITIONS

	July 16 Leading Edge of High with Northerly Winds (mixing depth ~4000')		July 17 Stagnation Period with Light and Variable Winds (mixing depth ~4500')			July 18 Trailing Edge of High with Southwest Winds (mixing depth ~3500')				
	Ground	4000'	Ground	3300'	4300'	Ground	1000'	2300'	4000'	6000'
Ethane	7.0	5.0	15.5	17.5	8.0	9.5	8.0	10.5	7.0	5.5
Ethylene	3.5	4.0	3.5	4.5	4.0	3.0	4.5	3.5	2.5	3.0
Acetylene	1.0	*	1.5	1.5	2.0	1.5	1.5	1.5	*	*
Propane	3.5	2.5	7.5	11.0	10.5	5.5	6.0	7.0	4.0	4.0
Propene	1.0	.5	.5	2.0	1.0	.5	3.0	1.5	1.0	1.0
i-Butane	1.5	.5	4.5	8.0	5.5	3.5	4.0	3.5	3.0	2.0
n-Butane	3.0	1.0	8.5	14.5	11.0	7.0	7.0	8.0	6.0	5.0
i-Pentane	3.0	1.0	7.0	11.0	9.0	6.5	6.5	7.5	3.0	2.5
n-Pentane	1.5	*	3.5	6.0	4.5	3.0	2.5	3.0	2.0	1.5
	25.0	14.5	52.0	76.0	55.5	40.0	43.0	46.0	28.5	24.5

* = Less than .5 μq/m³.

Table 5 illustrates an additional feature of the hydrocarbon data; this being that the subsidence inversion appears to serve as the upper dispersion limit for hydrocarbon emissions. It can be seen that a significant difference in light hydrocarbon levels exists above and below the inversion on July 18.

If advection of a contaminated air mass is a valid explanation for the changes in the hydrocarbon levels in this sequence of days, in addition to the higher hydrocarbon content, hydrocarbon ratios in the air samples collected on July 17 and 18 should reflect the "aging" of the air mass. This means that the relative amount of reactive hydrocarbons should be lower in the air that has been exposed to sunlight and oxides of nitrogen for the greatest length of time. Normally, the ratio of ethylene and/or propylene to acetylene is used to assess the "photochemical age" of a polluted air mass. We don't feel secure in using acetylene and propylene because in most aircraft-collected samples, they are present at levels approaching the lower detection limit (.5 $\mu g/m^3$) of the analytical method. However, it is also reasonable to select ethane as the unreactive species and to ratio it with ethylene. Ethylene/ethane ratios are shown in Table 6, and the trend from July 16 to 17 to 18 does support a conclusion of air mass aging. Less ethylene relative to ethane was present in the air samples collected during the stagnation period (July 17 and 18). The data shown in Table 6 are from aircraft samples collected during the morning hours before extensive mixing has begun and thus the sampled air was isolated from most ground level sources of these two hydrocarbons. Although the use of this ratio or any other as evidence of air mass aging can be questioned, it appears to provide the most reliable measure available using data we collected.

TABLE 6. ETHYLENE TO ETHANE RATIOS IN AIRCRAFT SAMPLES COLLECTED DURING THE MORNING HOURS OF JULY 16-19

	July 16	July 17	July 18	July 19
Ethylene ($\mu g/m^3$)	4.0	3.0	2.0	7.0
Ethane ($\mu g/m^3$)	5.5	6.5	6.0	6.0
Ethylene/Ethane	.72	.46	.33	1.2

Little has been said to this point about absolute hydrocarbon levels. Since we measured only the light hydrocarbons, a comparison to the Federal Standard, which includes all non-methane hydrocarbons, is not very meaningful. However, it is obvious from Table 2 that the Canton downtown area exceeds the 160 $\mu g/m^3$ ambient air standard most of the time. The light hydrocarbons alone averaged over 300 $\mu g/m^3$ in the 6:00 - 9:00 AM samples.

At the other extreme, it appears from the aircraft and cleanest ground data that a total light hydrocarbon burden of 15 to 25 $\mu g/m^3$ represents the so-called "background" level for this test period.

Much additional hydrocarbon information is contained in the Appendix section of this report. Methane and non-methane total hydrocarbon data from the Beckman 6800 is provided there in the form of hourly averages. Since both of these measurements showed the normal diurnal pattern they need no special mention. Also contained in the Appendix is a complete record of all aircraft bag analyses plus a map showing the collection location.

CARBON MONOXIDE

Carbon monoxide was monitored continuously at the Malone College site. The usual urban diurnal pattern was observed with maximum CO levels recorded during the morning peak traffic period (7:00-8:00 AM). Maximum concentrations never exceeded 10 ppm with the normal high being 4-5 ppm. During afternoon hours a constant level of about 1 ppm was generally registered.

Carbon monoxide levels were somewhat higher downtown than at Malone. A comparison of CO concentrations in bags collected simultaneously at the downtown site (Table 2) and Malone College (Table 3) shows close agreement on many mornings but generally about a two-fold higher concentration in the downtown area during afternoon hours. Thus peak levels in the downtown area probably seldom exceed 10 ppm and therefore are well below the Federal Air Quality Standard.

The continuous CO record is summarized in the Appendix in the form of hourly averages.

OXIDES OF NITROGEN

NO_x data was gathered continuously at the Malone College site. The usual type of diurnal pattern was observed with NO and NO_2 being highest during nighttime hours and during the morning peak traffic time. Hourly averages for NO_x never exceeded 200 ppb and normally varied between 100 and 150 ppb during the high periods. Afternoon concentrations were generally less than 50 ppb. A complete summary of the continuous NO and NO_2 data is contained in the Appendix.

NO_x measurements from bag samples collected at the downtown site exhibited similar behavior to that described above. Table 3 shows that over the three week sampling period, morning NO_x levels averaged 90 ppb and the afternoon average was 40 ppb.

NO_x levels in aircraft-collected bags were lower, generally falling in the range of 15 to 25 ppb. There was no recognizable diurnal change in the samples collected aloft and concentrations throughout this range were recorded in both mornings and afternoons.

Oxides of nitrogen measurements are of interest because of the integral part NO and NO_2 play in atmospheric photochemical processes. Therefore, the relationship between these species and hydrocarbons and ozone should be mentioned. From the downtown Canton data presented in Table 2 it can be seen that during the 6-9 AM sampling period, an average hydrocarbon to NO_x ratio of about 10 prevailed. This is in the range commonly encountered in other U.S. cities, and thus the potential for photochemical oxidant production certainly exists in the Canton urban air mass.

Nitric oxide, in addition to being a necessary ingredient for oxidant production, can also serve as a sink for ozone. This latter quality is the major reason why low ozone levels are registered in urban areas during nighttime hours. On many nights near-zero ozone levels were recorded at the Malone College site, indicating the presence of excessive amounts of nitric oxide. Of interest also is data collected on certain flights which seem to indicate that, at times, the urban plume downwind of the city is depleted in ozone. The evening flight on July 25 showed ozone levels of about 80 ppb in the air upwind of Canton while the levels downwind were in the 50-60 ppb range (see pg A-125 for flight map and other details).

The afternoon flight on July 5 provided another example of an urban plume that was presumably rich in nitric oxide and definitely deficient in ozone. Figure 16 shows a portion of the continuous ozone record obtained as our aircraft flew about 10 miles downwind of Wheeling, W. Va. The city of Wheeling lies in a U-shape with a ridge of hills filling the middle. The two distinct valleys in the ozone profile correspond to plumes emanating from the separated sections of Wheeling. These ozone dips were especially noticeable because of large distances on either side of Wheeling the levels had remained very constant. A bag sample (see bag A-6 on pg A-27) was collected as the aircraft passed through the plume at 4:39 PM. The NO_x level measured in this bag was 38 ppb and thus definitely above the 15-25 ppb range normally seen.

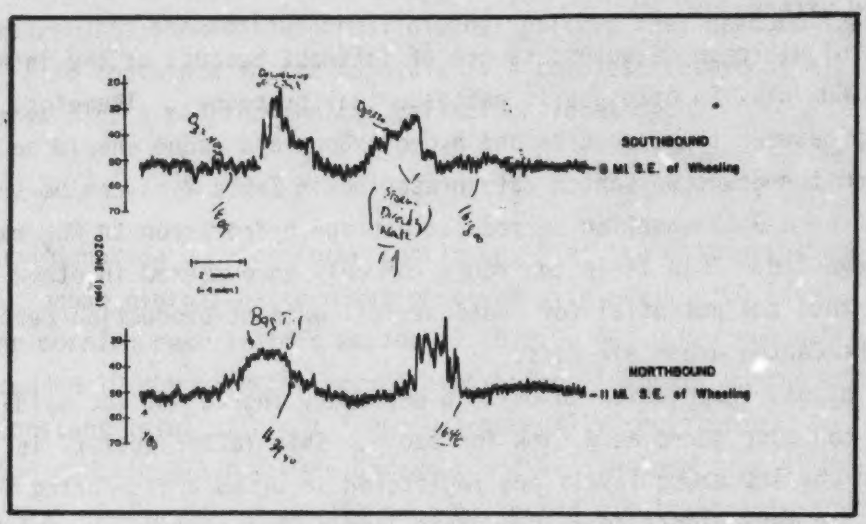

Figure 16. Ozone recordings downwind of Wheeling, WV.

SECTION 5

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APPENDIX A

Ozone, nitric oxide, nitrogen dioxide, non-methane total hydrocarbon, carbon monoxide and methane concentrations are listed in this section. Meteorological parameters including wind speed, wind direction, temperature, dew point, relative humidity and solar radiation are also tabulated. The data are compiled on a daily basis and recorded as hourly averages. Time is Eastern Daylight Time.

TABLE A-1

CONTINUOUS GROUND DATA

CANTON, OHIO

July 1, 1974

	GAS	DATA					MET.	DATA				
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	22	10	60	.4	1.4	1.8	0	4	343	19	14	75
0200	2	38	82	.5	1.9	2.0	0	4	283	17	14	80
0300	27	10	42	.2	1.1	1.9	0	2	276	17	14	82
0400	3	16	82	.8	1.6	2.3	0	4	250	16	13	83
0500	7	14	60	.5	1.3	2.2	0	4	241	16	13	83
0600	7	16	58	.4	1.3	2.1	0	3	239	16	13	84
0700	3	69	66	.8	2.7	2.3	62	3	243	15	13	85
0800	17	109	100	1.6	319	2.4	309	4	238	17	14	81
0900	42	15	60	.6	1.6	1.9	584	5	222	21	14	64
1000	35	11	21	.1	.9	1.7	882	11	243	23	11	49
1100	46	7	18	.1	.9	1.7	1119	11	236	24	11	45
1200	63	4	17	.1	.8	1.6	1315	11	245	25	11	40
1300	--	--	--	.1	.8	1.6	1439	16	261	26	10	36
1400	--	--	--	--	--	--	1476	14	257	27	9	32
1500	68	6	15	.1	.9	1.6	1443	16	268	28	9	31
1600	66	7	20	.1	.8	1.6	1066	15	246	29	10	32
1700	65	6	16	.1	.9	1.6	993	11	254	29	11	32
1800	60	6	22	.1	.9	1.6	578	10	288	28	11	33
1900	61	7	16	.1	.9	1.6	626	10	276	29	10	31
2000	50	10	34	.1	1.0	1.6	279	8	293	28	10	33
2100	16	8	87	.7	2.5	1.7	88	7	254	27	11	37
2200	2	37	105	.9	3.2	1.9	0	1	243	23	11	47
2300	3	48	100	1.6	3.7	2.1	0	1	218	22	12	54
2400	7	13	85	--	--	--	0	1	220	21	12	58

TABLE A-2

CONTINUOUS GROUND DATA

CANTON, OHIO

July 2, 1974

	GAS		DATA						MET.	DATA		
Time	**O_3**	**NO**	**NO_2**	**NMTHC**	**CO**	**CH_4**	**RAD**	**WS**	**WD**	**TMP**	**DP**	**RH**
hr	**ppb**	**ppb**	**ppb**	**ppm**	**ppm**	**ppm**	**mLy**	**mph**	**deg**	**°C**	**°C**	**%**
0100	35	10	42	--	--	--	0	1	222	20	12	58
0200	42	10	37	--	--	--	0	1	235	20	12	58
0300	35	10	40	--	--	--	0	4	237	20	12	59
0400	33	10	43	--	--	--	0	2	234	19	12	61
0500	41	10	28	--	--	--	0	4	233	19	11	61
0600	18	10	50	.5	1.2	2.1	0	2	223	18	11	63
0700	25	15	57	.5	1.5	2.0	94	3	215	18	11	64
0800	22	34	74	.6	2.0	2.0	278	4	203	20	12	58
0900	56	16	44	.5	1.6	1.8	528	8	219	23	14	54
1000	68	16	29	.4	1.0	1.8	826	13	230	25	16	57
1100	82	16	19	.1	.9	1.8	1033	12	242	27	18	58
1200	85	15	19	.2	1.0	1.8	885	13	245	28	19	56
1300	87	14	18	.1	1.0	1.8	1023	11	243	29	19	54
1400	89	14	19	.1	1.0	1.8	831	11	243	30	19	53
1500	86	14	19	.1	1.0	1.8	718	12	239	30	19	53
1600	86	14	24	.1	1.1	1.7	760	10	241	30	20	52
1700	85	11	26	.2	1.2	1.7	594	11	238	30	20	55
1800	90	10	24	.2	1.1	1.7	601	12	219	30	19	52
1900	85	10	26	.3	1.1	1.7	492	14	225	30	19	50
2000	83	9	29	.3	1.1	1.7	321	12	222	30	19	52
2100	62	5	16	.2	1.2	1.8	89	14	230	28	18	56
2200	43	14	40	.5	1.5	1.8	5	15	232	27	18	59
2300	47	17	30	.1	.9	1.8	0	12	237	26	18	61
2400	57	19	20	.1	.9	1.8	0	13	236	25	17	62

TABLE A-3

CONTINUOUS GROUND DATA

CANTON, OHIO

July 3, 1974

	GAS	DATA					MET.	DATA				
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	55	20	17	.1	.8	1.8	0	12	243	25	18	64
0200	51	20	16	.1	.8	1.8	0	10	237	24	17	65
0300	45	20	15	.2	.9	1.8	0	14	239	24	17	67
0400	39	18	19	.2	.9	1.8	0	11	240	23	17	70
0500	40	17	15	.1	.8	1.9	0	11	238	23	17	71
0600	18	18	23	.4	1.0	1.9	0	7	239	22	17	74
0700	30	19	41	.6	1.4	1.9	44	7	238	22	17	74
0800	38	20	31	.3	1.3	1.8	258	10	235	23	17	70
0900	49	19	25	.2	1.0	1.8	536	9	239	25	18	64
1000	63	18	18	.1	.9	1.7	823	13	243	27	18	59
1100	75	14	20	.1	.9	1.7	1064	9	262	29	19	55
1200	83	15	17	.1	.9	1.7	1258	11	262	30	19	52
1300	83	18	15	.1	.8	1.7	1392	11	251	31	20	51
1400	84	16	16	.1	.9	1.7	1178	12	240	32	20	48
1500	87	14	15	.1	.9	1.7	1366	11	249	33	20	47
1600	89	14	18	--	--	--	794	11	243	33	20	46
1700	91	12	20	--	--	--	1024	12	252	33	19	44
1800	108	9	18	--	--	--	775	13	240	33	19	44
1900	111	9	23	--	--	--	483	11	237	32	19	46
2000	99	8	22	--	--	--	263	10	244	31	19	49
2100	69	8	41	.4	1.4	1.7	86	9	236	29	19	53
2200	60	9	36	.2	--	1.8	0	7	224	28	19	57
2300	44	15	28	.2	--	1.8	0	9	226	27	18	61
2400	44	20	29	.4	--	1.8	0	9	225	25	19	66

TABLE A-4

CONTINUOUS GROUND DATA

CANTON, OHIO

July 4, 1974

	GAS	DATA					MET.	DATA				
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	42	20	27	.3	--	1.8	0	6	237	25	18	65
0200	42	17	25	.2	--	1.8	0	7	232	24	17	66
0300	47	17	20	.2	--	1.8	0	9	227	24	18	69
0400	45	16	17	.4	--	1.8	0	8	229	23	18	70
0500	37	15	22	.5	--	1.8	0	8	227	23	17	71
0600	17	15	25	.6	--	1.8	0	7	236	22	17	72
0700	35	16	25	.4	--	1.9	41	5	218	22	17	73
0800	42	19	23	.3	1.3	1.8	239	5	212	24	18	69
0900	53	21	17	.3	1.2	1.8	518	8	218	26	18	64
1000	63	20	17	.3	1.2	1.8	800	10	233	27	18	57
1100	74	18	13	.1	1.0	1.8	1053	9	221	29	18	54
1200	75	13	14	--	--	--	1266	13	241	30	19	51
1300	78	11	13	.2	.9	1.7	1363	9	219	32	20	48
1400	89	10	15	.1	.8	1.7	1367	16	223	33	19	44
1500	86	9	11	.1	.8	1.7	1407	15	219	33	18	42
1600	86	10	13	.1	.7	1.8	1214	15	230	32	17	41
1700	86	10	15	0	1.0	1.8	1066	13	228	32	17	39
1800	79	7	16	0	.9	1.8	735	14	236	32	17	41
1900	69	10	20	.1	1.0	1.8	453	14	224	31	17	43
2000	65	12	19	0	.9	1.8	103	11	238	39	17	47
2100	31	11	43	.3	1.4	1.9	28	9	270	23	15	61
2200	26	14	40	.1	1.3	1.9	0	4	216	21	16	72
2300	27	16	36	.2	1.4	2.0	0	6	230	21	16	73
2400	26	20	32	.2	1.2	1.9	0	4	219	20	16	74

TABLE A-5

CONTINUOUS GROUND DATA

CANTON, OHIO

July 5, 1974

	GAS	DATA					MET.	DATA				
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	27	21	26	.3	1.0	1.9	0	3	233	20	16	74
0200	25	24	19	.1	1.0	2.0	0	5	210	20	16	74
0300	24	24	14	.1	.9	1.9	0	6	224	20	16	74
0400	22	24	15	.1	.8	1.9	0	6	235	20	16	75
0500	21	20	15	.1	.8	1.9	0	5	252	20	16	74
0600	17	21	21	.2	.9	1.9	0	4	230	20	15	74
0700	7	30	35	.1	1.2	1.9	14	4	240	20	16	76
0800	11	33	30	.2	1.2	1.9	107	4	250	20	16	75
0900	18	27	30	.1	1.2	1.8	191	5	233	22	16	70
1000	17	28	24	.1	1.0	1.8	164	4	273	22	16	69
1100	17	29	32	.1	1.2	1.8	330	4	275	23	17	68
1200	17	31	43	.1	1.4	1.8	286	5	298	23	17	66
1300	37	29	31	.1	1.5	1.8	381	10	318	23	16	65
1400	66	22	31	.1	1.3	1.8	450	10	332	23	16	64
1500	70	20	38	.1	1.3	1.8	747	11	332	24	16	60
1600	83	17	25	.1	1.2	1.7	738	11	342	24	16	61
1700	77	15	27	.1	1.1	1.7	783	11	330	25	16	58
1800	81	12	24	.1	1.0	1.7	811	9	335	25	16	57
1900	70	20	24	.2	1.2	1.7	580	13	333	25	15	56
2000	75	10	45	.2	1.4	1.7	269	12	343	24	14	56
2100	31	16	76	.3	1.8	1.8	107	9	002	21	13	57
2200	24	15	65	.2	1.3	1.8	0	8	000	19	11	60
2300	22	13	44	.2	1.2	1.7	0	8	023	17	10	64
2400	12	20	46	.2	1.2	1.8	0	6	032	16	10	69

TABLE A-6

CONTINUOUS GROUND DATA

CANTON, OHIO

July 6, 1974

	GAS DATA						MET. DATA					
Time hr	**O_3 ppb**	**NO ppb**	**NO_2 ppb**	**NMTHC ppm**	**CO ppm**	**CH_4 ppm**	**RAD mLy**	**WS mph**	**WD deg**	**TMP °C**	**DP °C**	**RH %**
0100	18	11	35	.2	1.1	1.8	0	4	026	15	10	72
0200	5	16	44	.2	1.1	1.8	0	3	038	14	9	76
0300	3	13	41	.2	1.1	1.8	0	2	041	13	9	78
0400	19	8	26	.2	.9	1.8	0	1	023	12	9	80
0500	20	7	29	.2	.9	1.7	0	1	044	12	9	80
0600	16	9	32	.2	1.0	1.8	0	0	050	12	9	81
0700	16	15	30	.2	1.1	1.9	63	2	052	12	9	82
0800	25	14	24	.3	1.2	1.9	305	5	066	14	11	82
0900	34	14	13	.2	.9	1.7	598	8	097	18	11	66
1000	44	13	14	.2	.9	1.6	893	7	073	20	12	58
1100	48	13	18	.2	1.0	1.7	1134	6	067	22	12	54
1200	59	9	13	--	--	--	1353	7	083	24	13	51
1300	67	9	11	.4	.9	1.6	1473	6	038	25	12	47
1400	69	7	9	.2	.8	1.6	1501	5	036	26	12	42
1500	74	6	7	.2	.8	1.6	1457	4	065	27	11	37
1600	81	7	12	.2	.8	1.6	1338	6	052	27	11	36
1700	89	7	11	.2	.8	1.6	1146	5	090	28	11	35
1800	100	6	11	.3	.9	1.6	917	5	129	28	11	34
1900	99	7	18	.3	1.0	1.6	625	2	090	28	10	32
2000	94	6	37	.4	1.3	1.6	266	2	067	27	10	35
2100	23	8	91	.6	2.0	1.6	77	1	103	25	11	42
2200	13	25	109	.6	2.2	1.8	0	0	101	22	12	51
2300	9	37	96	.8	2.0	1.9	0	0	051	21	11	56
2400	2	48	96	.6	2.1	1.9	0	0	059	19	11	58

TABLE A-7

CONTINUOUS GROUND DATA

CANTON, OHIO

July 7, 1974

	GAS DATA						MET. DATA					
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	14	23	55	.7	1.4	1.6	0	1	056	18.2	10.9	63
0200	17	15	49	.4	1.2	1.9	0	4	050	17.6	12.0	69
0300	7	16	59	.4	1.4	1.9	0	1	058	16.5	12.3	76
0400	2	15	55	.5	1.5	2.1	0	1	120	15.4	11.9	80
0500	9	24	73	.8	1.8	2.3	0	1	310	15.2	11.7	80
0600	-	37	56	.5	1.5	2.1	0	1	040	15.0	11.4	79
0700	1	87	55	.7	2.2	2.2	46	1	010	15.1	12.1	82
0800	12	49	56	.6	1.9	2.2	267	1	073	17.3	14.2	82
0900	26	36	57	.5	1.5	2.2	562	1	073	20.2	15.0	72
1000	62	17	39	1.5	1.3	1.9	863	2	098	25.1	14.9	53
1100	92	7	13	.5	.9	1.6	1120	4	091	27.8	13.1	40
1200	98	7	14	.3	.8	1.6	1341	4	054	28.9	11.7	35
1300	114	7	18	.3	.8	1.6	1461	5	119	30.1	11.3	31
1400	116	8	15	.3	.8	1.6	1474	6	151	31.3	11.8	30
1500	121	7	17	.4	.9	1.7	1416	6	122	31.7	12.0	30
1600	135	8	20	.4	1.0	1.7	1277	5	266	32.4	12.4	30
1700	129	8	20	.4	.9	1.6	1089	6	061	31.7	12.2	30
1800	137	8	22	.4	1.0	1.6	844	6	043	31.0	12.3	32
1900	131	9	32	.4	1.0	1.6	612	6	034	30.8	12.1	32
2000	108	9	90	.5	1.4	1.6	274	6	028	29.9	11.4	32
2100	115	9	71	.5	1.6	1.7	95	4	034	27.8	12.6	39
2200	105	9	83	.5	1.7	1.7	0	6	022	25.1	13.9	50
2300	76	8	71	.6	2.2	1.8	0	5	035	23.6	13.2	52
2400	56	10	130	.7	1.8	2.0	0	4	081	21.8	13.2	58

TABLE A-8

CONTINUOUS GROUND DATA

CANTON, OHIO

July, 8, 1974

	GAS	DATA					MET.	DATA				
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	19	16	123	.7	1.9	2.0	0	2	075	20.7	13.8	65
0200	63	14	48	.6	1.7	1.9	0	1	091	19.8	14.5	71
0300	70	13	36	.8	1.5	2.1	0	2	206	19.8	14.2	70
0400	53	15	48	1.0	1.6	2.4	0	3	236	19.5	13.9	70
0500	48	15	48	1.1	1.7	2.3	0	2	223	18.3	13.4	73
0600	-	16	44	1.0	1.7	2.3	0	1	324	17.2	13.0	76
0700	9	98	88	1.2	2.5	2.5	39	1	248	17.2	13.2	77
0800	12	70	128	1.8	3.6	2.6	230	1	240	20.2	14.4	69
0990	56	26	55	1.3	2.4	1.9	489	4	248	24.0	14.8	57
1000	62	23	35	.7	1.4	1.7	738	7	295	26.0	16.1	54
1100	82	21	17	.7	1.0	1.8	991	7	301	27.9	17.7	54
1200	97	16	15	.5	.8	1.8	1272	9	316	29.4	18.4	52
1300	108	12	18	.4	.9	1.6	1343	8	304	30.8	18.1	47
1400	112	12	12	.4	.8	1.6	1400	7	338	31.3	17.3	43
1500	102	13	10	.3	.8	1.6	1361	6	300	32.1	16.6	40
1600	103	16	11	.4	.8	1.6	1272	6	277	32.9	15.7	36
1700	110	14	15	.4	.8	1.6	1067	6	319	32.4	16.0	37
1800	108	11	18	.4	.8	1.6	787	7	307	32.5	16.4	38
1900	106	10	16	.4	.9	1.6	518	5	285	32.2	16.4	39
2000	75	11	65	.5	1.1	1.6	268	6	334	31.2	16.0	40
2100	66	12	52	.5	1.7	1.8	81	2	064	29.9	16.0	43
2200	46	14	64	.6	1.8	1.8	0	3	244	27.8	16.7	51
2300	18	13	90	.9	2.1	2.0	0	2	239	26.8	17.1	55
2400	34	16	58	1.1	1.7	2.0	0	3	233	24.9	16.7	60

TABLE A-9

CONTINUOUS GROUND DATA

CANTON, OHIO

July 9, 1974

	GAS DATA						MET. DATA					
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	64	26	26	.3	1.0	1.8	0	8	241	24.3	16.3	61
0200	69	27	18	.2	.9	1.8	0	6	253	23.5	16.1	63
0300	67	26	19	.3	1.0	1.8	0	3	246	22.7	15.9	66
0400	44	26	35	.4	1.1	2.0	0	2	257	21.7	15.9	69
0500	28	26	54	.6	1.2	2.3	0	2	238	21.0	15.7	72
0600	-	25	53	.7	1.4	2.4	0	1	238	20.7	15.7	73
0700	13	32	83	.9	2.1	2.3	30	3	245	20.7	15.9	74
0800	21	40	80	.8	2.4	2.0	198	5	244	22.3	16.4	69
0900	49	29	36	.4	1.5	1.8	447	6	243	24.8	16.6	61
1000	80	27	24	.3	1.2	1.8	751	8	253	27.6	17.9	55
1100	101	29	16	.2	1.1	1.7	991	6	274	29.7	18.9	53
1200	118	25	12	.2	1.0	1.6	1108	9	274	31.0	18.7	48
1300	97	21	16	.2	.9	1.6	1059	8	285	31.7	18.6	46
1400	101	15	11	.2	.8	1.6	458	5	311	30.7	17.6	46
1500	100	11	9	.1	.8	1.6	1150	7	290	33.3	18.3	41
1600	90	13	31	.4	1.4	1.7	389	5	299	32.2	16.8	40
1700	68	20	34	.4	1.7	1.7	231	6	188	29.6	17.8	49
1800	58	23	40	.4	1.5	1.7	158	9	209	26.5	16.4	54
1900	64	29	46	.6	1.6	1.7	285	6	230	27.2	16.3	51
2000	54	18	36	.4	1.5	1.7	226	5	235	28.4	17.0	50
2100	42	17	47	.4	1.5	1.7	50	4	227	26.1	14.8	50
2200	25	26	60	.8	1.7	1.8	0	5	237	25.2	15.8	56
2300	38	33	45	.3	1.3	1.8	0	6	240	24.9	16.9	61
2400	35	26	31	.3	1.1	1.8	0	7	239	24.6	17.6	65

TABLE A-10

CONTINUOUS GROUND DATA

CANTON, OHIO

July 10, 1974

	GAS DATA						MET. DATA					
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	44	11	21	.2	1.0	1.7	0	6	308	24.8	18.0	66
0200	39	9	19	.5	1.3	1.9	0	2	132	23.8	16.6	64
0300	21	9	24	.7	1.2	2.0	0	2	228	23.2	17.0	68
0400	36	8	17	.3	1.0	1.8	0	4	236	23.0	17.8	73
0500	37	9	13	.3	.9	1.8	0	4	248	22.5	17.3	72
0600	-	8	15	.3	1.0	1.8	0	3	249	22.1	16.9	72
0700	18	10	26	.4	1.4	1.9	14	4	275	22.0	16.4	70
0800	19	13	33	.4	1.5	1.8	173	5	267	22.8	16.5	67
0900	40	11	29	.3	1.2	1.7	465	6	260	24.9	17.0	61
1000	51	12	23	.4	1.1	1.7	649	8	284	26.1	16.8	56
1100	91	11	20	.5	1.0	1.6	915	7	294	27.7	17.5	54
1200	113	7	17	.4	1.0	1.6	1116	9	282	29.7	18.1	50
1300	117	8	18	.4	1.0	1.6	1096	10	298	30.4	18.2	48
1400	127	11	25	.4	1.1	1.7	950	14	340	29.9	18.3	50
1500	129	16	29	.4	1.0	1.7	1203	16	338	29.3	18.5	52
1600	117	16	26	.3	1.2	1.6	963	17	340	29.6	18.7	52
1700	101	23	27	.3	1.3	1.6	831	16	344	28.7	17.6	51
1800	76	30	23	.3	1.2	1.6	659	15	009	28.2	17.1	51
1900	72	28	38	.3	1.3	1.7	397	14	003	26.8	16.2	52
2000	48	12	18	.3	1.0	1.6	187	10	005	26.2	16.4	55
2100	35	14	31	.3	1.1	1.6	57	6	009	25.1	16.1	57
2200	32	12	28	.3	1.2	1.7	0	6	358	23.9	15.9	61
2300	24	14	23	.3	1.1	1.7	0	6	348	23.2	15.8	63
2400	24	16	19	.4	1.1	1.8	0	5	006	22.9	15.7	64

TABLE A-11

CONTINUOUS GROUND DATA

CANTON, OHIO

July 11, 1974

	GAS DATA						MET. DATA					
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	28	16	16	.3	.9	1.7	0	5	013	22.4	16.0	67
0200	17	17	11	.3	.9	1.7	0	8	359	21.4	15.5	69
0300	34	13	8	.2	.9	1.7	0	7	033	21.0	15.1	69
0400	28	10	8	.2	.9	1.7	0	12	061	20.7	13.9	65
0500	21	12	7	.2	.8	1.7	0	8	058	18.8	12.0	65
0600	-	12	12	.3	.8	1.6	0	10	045	17.2	11.3	68
0700	10	17	11	.3	1.0	1.6	43	8	049	16.5	11.2	71
0800	12	18	9	.3	1.0	1.6	264	12	041	17.3	11.4	68
0990	18	15	5	.2	.9	1.6	570	11	053	18.4	11.1	62
1000	22	21	6	.2	.8	1.6	865	11	043	19.5	11.2	59
1100	34	14	6	.2	.8	1.6	1126	9	036	20.9	11.1	53
1200	37	9	18	.2	.8	1.6	1326	14	032	21.4	10.4	49
1300	42	7	11	.2	.8	1.6	1441	14	010	22.0	10.6	48
1400	44	7	18	-	-	-	1495	12	052	23.3	10.3	44
1500	48	5	23	.2	.7	1.6	1479	11	028	24.2	10.5	42
1600	52	4	16	.2	.8	1.6	1350	15	039	24.8	10.1	40
1700	47	11	20	.2	.8	1.6	1202	16	043	25.0	9.3	37
1800	45	8	25	.2	.8	1.6	973	15	044	24.6	6.7	32
1900	43	16	16	.2	.8	1.6	697	9	030	24.0	5.5	30
2000	45	10	26	.2	.9	1.6	276	11	048	22.6	5.2	32
2100	43	10	44	.2	1.0	1.6	108	10	038	20.3	5.0	36
2200	15	10	68	.3	1.1	1.6	0	6	026	17.4	4.7	43
2300	17	12	56	.3	1.1	1.7	0	1	023	15.6	5.2	50
2400	15	14	56	.3	1.1	1.7	0	1	016	14.7	5.6	55

TABLE A-12

CONTINUOUS GROUND DATA

CANTON, OHIO

July 12, 1974

	GAS DATA						MET. DATA					
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	26	7	39	.3	1.0	1.8	0	2	023	13.8	6.0	59
0200	29	9	26	.3	.8	1.8	0	3	036	13.5	6.3	62
0300	30	7	28	.2	.8	1.8	0	1	043	12.9	6.2	64
0400	24	11	44	.3	.9	2.0	0	1	064	11.8	6.2	68
0500	22	7	28	.3	.8	2.0	0	1	047	10.9	5.9	71
0600	-	34	57	.3	1.1	2.0	0	1	048	10.9	5.9	71
0700	3	86	61	.4	1.8	1.9	47	1	042	10.5	6.4	76
0800	7	83	57	.5	2.7	1.9	295	2	078	14.1	7.7	65
0900	17	32	56	.4	1.6	1.8	510	3	085	16.8	7.5	54
1000	41	11	15	.2	1.3	1.7	796	6	096	19.0	7.9	48
1100	43	9	13	.3	.9	1.7	1045	6	091	21.2	7.2	40
1200	52	8	12	.2	.8	1.6	1215	3	125	22.7	6.6	35
1300	67	6	11	.2	.8	1.6	1409	6	092	24.1	7.0	33
1400	74	9	11	.2	.8	1.6	1428	1	043	25.1	6.7	31
1500	90	6	14	.2	.9	1.7	1411	3	019	26.2	7.1	30
1600	92	6	14	.1	.9	1.7	1326	2	351	27.0	8.0	30
1700	76	8	10	.1	.8	1.6	1118	8	002	27.1	8.0	30
1800	83	7	26	.1	.8	1.6	891	6	017	26.5	7.3	30
1900	84	8	36	.2	.9	1.5	617	2	037	26.7	8.0	31
2000	60	11	43	.2	1.0	1.5	266	3	052	26.0	8.7	34
2100	109	9	89	.4	2.0	1.7	115	3	021	24.1	10.0	40
2200	54	8	109	.4	1.9	1.7	0	1	022	21.0	11.4	54
2300	25	11	89	.4	1.7	1.7	0	1	031	18.9	10.4	58
2400	18	18	94	.3	1.4	1.7	0	1	030	17.8	10.0	60

TABLE A-13

CONTINOUS GROUND DATA

CANTON, OHIO

July 13, 1974

	GAS	DATA					MET.	DATA				
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	18	18	77	.5	1.7	1.7	0	1	060	16.7	9.7	63
0200	19	10	66	.5	1.6	1.8	0	1	096	15.5	9.5	67
0300	1	28	84	.9	2.1	2.0	0	1	152	14.0	9.3	73
0400	20	9	55	1.2	1.8	2.3	0	1	184	13.5	9.4	76
0500	16	7	57	1.1	1.6	2.6	0	1	209	13.6	9.2	74
0600	-	9	54	1.0	1.4	2.6	0	1	161	12.5	8.8	78
0700	19	11	45	1.2	1.7	2.6	44	1	162	12.8	9.2	79
0800	21	26	61	1.3	2.2	2.5	234	1	175	16.5	10.8	69
0900	28	29	65	.8	2.3	2.1	533	1	205	20.5	11.2	55
1000	64	11	29	.3	1.2	1.7	825	2	240	23.4	11.5	47
1100	80	9	23	.3	1.0	1.6	1094	5	286	25.5	11.7	42
1200	79	7	18	.2	.9	1.6	1309	6	284	26.9	11.1	37
1300	110	5	18	.2	1.0	1.8	1422	6	284	28.2	7.4	27
1400	110	7	17	.2	.9	1.6	1458	4	267	29.5	7.7	26
1500	96	7	14	.2	.8	1.6	1424	3	294	30.1	7.8	25
1600	88	6	8	.2	.7	1.5	1315	4	305	30.4	7.8	24
1700	91	5	12	.2	.7	1.5	1151	5	303	31.0	7.2	22
1800	88	6	11	.2	.7	1.5	906	5	288	30.7	7.0	23
1900	88	6	15	.2	.7	1.5	614	7	305	30.4	7.3	24
2000	80	6	45	.2	.9	1.5	239	2	314	29.8	7.5	25
2100	101	75	162	.6	2.4	1.6	62	1	354	27.6	8.1	29
2200	34	7	83	.7	2.0	1.7	0	1	284	24.2	9.0	38
2300	36	8	67	.5	1.6	1.8	0	1	245	24.2	10.2	41
2400	38	8	63	.5	1.5	1.7	0	1	250	22.8	10.1	45

TABLE A-14

CONTINUOUS GROUND DATA

CANTON, OHIO

July 14, 1974

	GAS DATA						MET. DATA					
Time	O_3	NO	NO_2	NMTHC	CO	CH_4	RAD	WS	WD	TMP	DP	RH
hr	ppb	ppb	ppb	ppm	ppm	ppm	mLy	mph	deg	°C	°C	%
0100	52	8	40	.4	1.2	1.7	0	4	241	22.2	9.9	46
0200	57	9	30	.4	1.1	1.7	0	1	241	21.3	10.5	50
0300	57	9	28	.3	1.0	1.7	0	2	261	20.6	10.8	53
0400	57	10	21	.3	.9	1.7	0	2	257	20.3	10.8	54
0500	56	9	21	.3	.9	1.7	0	1	279	20.5	10.8	54
0600	-	10	23	.4	1.0	1.8	0	2	247	20.5	10.7	53
0700	42	11	35	.6	1.3	2.1	20	1	206	19.6	10.7	56
0800	51	9	35	.6	1.2	1.8	197	1	239	20.9	11.4	54
0900	63	10	22	.3	1.0	1.7	491	4	260	24.0	12.3	48
1000	65	13	24	.3	1.0	1.7	772	6	246	26.6	13.6	45
1100	80	12	17	.3	.9	1.6	1053	10	259	29.0	15.5	44
1200	83	9	16	.3	.9	1.6	1239	12	275	30.8	16.7	43
1300	90	8	16	.2	.9	1.6	1330	15	256	31.6	17.3	42
1400	97	7	15	.3	.8	1.5	1358	11	288	32.8	17.8	41
1500	92	7	15	.2	.8	1.5	1373	10	265	34.1	18.6	40
1600	87	11	12	.2	.8	1.5	885	12	273	33.8	18.9	41
1700	80	14	13	-	-	-	699	12	262	34.2	19.1	41
1800	73	20	14	.3	.9	1.5	554	10	254	32.9	18.8	44
1900	78	27	13	.3	1.0	1.6	439	12	258	32.3	19.1	46
2000	83	30	17	.3	1.1	1.6	241	16	247	30.7	19.0	50
2100	56	23	21	.3	1.0	1.6	99	8	207	28.9	18.3	53
2200	55	20	17	.3	1.0	1.7	0	11	178	26.2	16.2	54
2300	43	23	16	.1	1.0	1.6	0	9	140	24.9	15.4	56
2400	44	23	11	.2	.8	1.5	0	14	332	20.8	14.6	68

TABLE A-15

CONTINUOUS GROUND DATA

CANTON, OHIO

July 15, 1974

	GAS DATA						MET. DATA					
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	36	21	11	.2	.7	1.5	0	13	267	19.9	14.5	71
0200	26	24	16	.2	.8	1.6	0	4	255	20.4	15.9	75
0300	28	22	13	.2	.7	1.6	0	2	238	20.6	16.6	78
0400	21	34	21	.3	1.0	1.7	0	3	269	20.0	16.0	78
0500	19	33	22	.6	.9	1.8	0	5	234	19.8	15.6	77
0600	-	33	38	.6	1.1	1.9	0	2	250	19.6	15.5	77
0700	2	48	61	.6	1.9	1.9	22	1	258	19.5	15.7	79
0800	3	66	56	.5	1.7	1.8	135	4	293	20.5	16.7	79
0900	17	42	28	.3	1.3	1.7	288	8	349	21.1	16.9	77
1000	25	41	44	.3	1.3	1.6	653	12	346	21.7	15.1	66
1100	62	22	32	.3	1.4	1.7	1009	10	352	23.4	13.0	52
1200	69	21	29	.3	1.4	1.7	1250	10	336	24.9	13.6	49
1300	72	13	21	.3	1.2	1.6	1381	15	329	25.7	12.9	45
1400	60	8	21	.2	1.1	1.6	1460	17	337	26.4	11.2	39
1500	74	9	23	.2	1.3	1.6	1422	18	332	27.0	10.3	35
1600	74	7	20	.2	1.4	1.6	1029	19	345	26.6	11.8	40
1700	75	8	33	.2	1.4	1.7	927	17	349	26.1	12.8	44
1800	70	11	44	.3	1.7	1.7	741	15	001	25.7	13.2	46
1900	70	9	30	.2	1.4	1.7	521	15	003	25.0	12.8	47
2000	52	9	28	.3	1.5	1.7	257	14	018	24.2	12.9	49
2100	23	13	39	.2	1.3	1.7	65	11	004	22.1	13.2	57
2200	6	21	39	.2	1.1	1.7	0	11	010	20.2	12.1	60
2300	3	13	38	.2	1.1	1.7	0	9	348	18.8	10.5	59
2400	4	13	36	.2	1.0	1.7	0	7	348	17.9	9.5	58

TABLE A-16

CONTINUOUS GROUND DATA

CANTON, OHIO

July 16, 1974

	GAS DATA						MET. DATA					
Time	O_3	NO	NO_2	NMTHC	CO	CH_4	RAD	WS	WD	TMP	DP	RH
hr	ppb	ppb	ppb	ppm	ppm	ppm	mLy	mph	deg	°C	°C	%
0100	4	13	32	.2	1.0	1.7	0	8	355	17.1	8.9	59
0200	3	17	25	.2	1.0	1.8	0	5	348	15.8	8.7	63
0300	9	10	17	.2	.9	1.8	0	6	003	15.2	9.0	66
0400	4	12	25	.3	.8	1.8	0	6	348	15.0	8.8	67
0500	2	15	34	.3	.9	1.8	0	6	335	14.6	9.0	69
0600	-	45	29	.4	1.1	1.9	0	5	348	14.1	9.0	71
0700	0	112	35	.6	1.8	2.2	34	4	325	13.9	9.2	73
0800	2	80	44	.6	1.8	2.0	251	3	337	15.2	10.1	72
0900	15	25	33	.3	1.2	1.8	550	8	348	17.3	10.3	63
1000	25	17	21	.2	1.1	1.7	843	10	355	18.6	9.7	56
1100	32	49	3	.2	1.1	1.7	1094	11	353	20.0	8.8	48
1200	45	12	20	.2	.9	1.6	1303	12	016	21.3	8.7	45
1300	55	7	17	.1	.7	1.6	1428	5	032	21.9	8.7	43
1400	49	7	18	.1	.7	1.6	1479	1	003	22.8	8.4	40
1500	46	8	24	-	-	-	1441	1	017	23.4	8.5	39
1600	47	10	25	.2	.8	1.6	1339	2	346	24.6	9.3	38
1700	47	11	22	.2	.8	1.6	1146	7	360	24.8	10.0	39
1800	40	9	26	.2	.8	1.6	920	3	044	24.9	10.0	39
1900	41	10	39	.2	.9	1.6	642	9	022	24.4	9.9	40
2000	34	11	38	.2	.9	1.6	295	7	011	23.4	9.3	41
2100	30	8	14	.3	1.0	1.7	90	4	003	21.6	9.0	44
2200	11	12	21	.4	1.1	1.7	0	1	358	18.7	6.9	46
2300	0	36	34	.3	1.3	1.7	0	1	021	17.1	5.1	45
2400	2	14	24	.3	1.2	1.7	0	1	023	15.7	4.5	47

TABLE A-17

CONTINUOUS GROUND DATA

CANTON, OHIO

July 17, 1974

	GAS DATA						MET. DATA					
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	0	36	43	.5	1.5	1.8	0	1	099	14.7	4.7	51
0200	0	36	51	.5	1.5	2.0	0	1	089	13.6	5.8	59
0300	0	34	55	.5	1.3	2.1	0	1	086	12.9	6.3	64
0400	0	24	50	.3	1.1	1.9	0	1	064	12.4	6.3	66
0500	0	61	59	.4	1.3	1.9	0	1	061	11.4	6.2	70
0600	-	135	44	.4	2.0	1.9	0	1	088	10.6	5.9	73
0700	0	139	37	.7	3.3	2.1	35	1	040	11.3	6.2	71
0800	5	70	66	.7	2.5	2.1	261	1	094	14.6	7.5	62
0900	23	33	67	.8	2.3	2.2	554	1	119	18.7	8.5	52
1000	38	12	27	.4	1.2	1.9	844	1	166	21.8	9.0	44
1100	49	10	28	.4	1.1	1.8	1078	2	299	24.2	9.6	40
1200	69	9	29	.3	1.2	1.8	1274	2	284	25.4	10.0	38
1300	77	9	27	.3	1.1	1.8	1402	1	308	26.4	11.0	38
1400	81	7	24	.3	1.0	1.8	1385	1	214	28.4	10.4	33
1500	86	8	25	-	-	-	1403	2	170	29.5	10.7	31
1600	87	6	30	.2	1.0	1.7	976	4	235	29.4	10.7	31
1700	83	6	21	.3	1.0	1.7	866	4	237	28.6	10.1	32
1800	91	5	21	.3	1.0	1.7	449	4	184	27.5	10.1	34
1900	87	5	23	.2	.9	1.7	499	4	179	27.3	10.3	35
2000	63	4	26	.3	1.1	1.7	273	2	193	27.4	10.3	34
2100	30	5	71	.5	1.9	1.8	67	1	244	25.5	9.0	35
2200	8	8	121	.9	3.0	2.1	0	1	212	22.4	9.5	44
2300	33	5	62	1.0	1.9	2.6	0	1	171	22.1	10.5	48
2400	45	6	31	.7	1.1	2.5	0	4	197	21.4	11.3	53

TABLE A-18

CONTINUOUS GROUND DATA

CANTON, OHIO

July 18, 1974

	GAS DATA						MET. DATA					
Time	O_3	NO	NO_2	NMTHC	CO	CH_4	RAD	WS	WD	TMP	DP	RH
hr	ppb	ppb	ppb	ppm	ppm	ppm	mLy	mph	deg	°C	°C	%
0100	48	6	25	.7	1.0	2.4	0	2	176	21.3	11.4	53
0200	49	8	22	.5	1.0	2.2	0	1	219	21.0	11.5	54
0300	46	10	25	.5	1.0	2.3	0	2	178	20.7	11.4	55
0400	43	9	24	.5	1.0	2.3	0	1	197	19.9	11.5	58
0500	35	9	26	.7	1.0	2.4	0	1	186	19.5	11.6	60
0600	-	11	37	.8	1.1	2.5	0	1	176	18.9	11.6	62
0700	14	15	72	.8	1.8	2.3	2	2	205	19.1	11.6	61
0800	20	22	70	.8	1.7	2.0	162	4	234	20.4	11.8	58
0900	32	17	49	.4	1.2	1.9	241	7	240	22.1	12.0	53
1000	59	12	23	.3	1.0	1.7	669	6	249	23.8	12.6	49
1100	70	8	17	.2	.8	1.7	1072	10	255	26.8	13.4	44
1200	74	7	18	.3	.8	1.6	1270	12	279	28.4	13.8	41
1300	75	6	15	.3	.8	1.6	1235	12	272	29.5	14.0	39
1400	74	6	24	.3	.9	1.6	1112	12	254	30.6	14.3	37
1500	72	6	18	.2	1.0	1.6	547	10	263	29.0	13.5	39
1600	86	7	21	.3	1.0	1.7	585	13	245	29.3	13.4	38
1700	93	7	30	.4	1.2	1.6	563	14	260	29.3	13.9	39
1800	100	8	27	.5	1.1	1.6	497	13	250	28.9	14.4	41
1900	103	8	26	.5	1.2	1.7	540	12	246	29.5	15.9	44
2000	95	8	41	.5	1.3	1.7	141	13	243	28.4	15.4	45
2100	76	8	51	.9	1.6	1.8	65	9	243	27.6	15.4	47
2200	88	8	37	.9	1.3	1.8	3	9	241	26.5	14.7	48
2300	85	9	37	.9	1.3	1.8	0	10	235	26.0	14.2	48
2400	81	8	27	1.0	1.2	1.7	0	9	243	25.4	13.7	48

TABLE A-19

CONTINUOUS GROUND DATA

CANTON, OHIO

July 19, 1974

	GAS	DATA					MET.	DATA				
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	83	9	21	1.1	1.0	1.7	0	7	251	24.8	13.7	50
0200	75	11	23	1.3	1.0	1.7	0	7	251	24.4	14.0	52
0300	62	12	29	1.5	1.1	1.7	0	5	249	23.8	14.2	55
0400	56	14	29	1.6	1.1	1.7	0	5	257	23.1	14.4	58
0500	53	15	20	1.4	1.0	1.7	0	3	282	22.6	14.6	61
0600	-	18	25	1.1	1.1	1.7	0	5	275	22.3	14.7	62
0700	26	21	42	.7	1.4	1.8	30	6	281	21.8	14.9	65
0800	25	27	36	.7	1.3	1.7	221	7	281	22.9	16.0	65
0900	28	28	39	.8	1.3	1.8	464	11	305	24.3	16.8	63
1000	41	26	40	1.1	1.3	1.8	357	9	309	24.3	16.7	63
1100	45	27	38	1.4	1.2	1.7	761	12	326	25.6	17.3	60
1200	73	21	36	1.5	1.2	1.7	767	10	307	26.8	17.0	55
1300	61	10	19	.2	1.0	1.6	1193	14	323	28.3	16.3	48
1400	56	11	21	.2	1.0	1.6	1446	15	338	29.1	14.3	40
1500	49	12	20	.2	1.1	1.6	1072	17	336	29.3	14.3	40
1600	36	15	27	.1	1.1	1.7	768	14	346	28.4	14.1	42
1700	41	12	25	.1	1.2	1.7	850	17	340	27.4	13.7	43
1800	56	10	26	.1	1.2	1.7	717	15	358	27.4	13.4	42
1900	52	9	43	.2	1.2	1.7	466	16	358	26.9	12.7	42
2000	45	10	44	.1	1.4	1.7	198	9	010	25.8	13.2	46
2100	11	27	54	.1	1.3	1.7	62	4	019	24.2	13.2	50
2200	2	36	58	.1	1.1	1.7	0	2	353	22.3	12.1	52
2300	6	20	44	.1	1.0	1.7	0	6	359	21.4	11.3	53
2400	3	28	36	.2	1.2	1.7	0	3	010	20.7	11.1	54

TABLE A-20

CONTINUOUS GROUND DATA

CANTON, OHIO

July 20, 1974

	GAS DATA						MET. DATA					
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	10	14	25	.1	.9	1.7	0	4	019	19.8	10.8	56
0200	10	14	26	.1	.9	1.7	0	2	012	19.2	10.5	57
0300	13	13	21	.1	.8	1.7	0	6	014	18.9	10.9	59
0400	12	15	15	.1	.8	1.7	0	7	015	18.3	11.1	63
0500	13	16	10	.1	.7	1.7	0	7	021	17.8	11.3	66
0600	-	14	16	.1	.8	1.7	0	7	021	16.8	10.7	67
0700	9	18	20	.1	.8	1.7	26	6	021	16.0	10.1	68
0800	11	22	14	.2	.8	1.7	208	3	031	16.6	10.2	66
0900	15	17	21	.2	.8	1.7	504	3	026	17.7	10.1	61
1000	18	19	18	.1	.8	1.6	805	9	057	18.9	10.2	57
1100	22	10	17	.1	.7	1.6	1065	9	030	20.2	10.2	53
1200	32	8	11	.0	.7	1.6	1294	8	030	21.3	10.0	49
1300	42	7	8	.1	.7	1.6	1459	9	010	22.4	9.8	45
1400	43	9	12	.1	.7	1.6	1506	13	026	23.2	8.7	40
1500	47	8	18	.1	.7	1.6	1474	11	034	24.1	9.3	39
1600	46	9	12	.1	.7	1.6	1365	10	029	24.5	9.3	38
1700	46	9	4	.1	.7	1.6	1158	13	024	23.9	9.3	39
1800	41	7	13	.1	.7	1.6	913	11	012	22.7	8.2	39
1900	30	8	21	.1	.7	1.6	624	11	042	22.1	7.7	39
2000	23	11	23	.1	.9	1.6	253	10	049	21.2	6.8	39
2100	19	8	34	.1	.9	1.6	71	7	030	19.3	7.2	45
2200	14	10	37	.1	.9	1.6	0	6	017	17.1	6.6	50
2300	10	21	32	.1	.9	1.7	0	3	024	16.0	6.3	52
2400	11	13	46	.2	1.0	1.7	0	1	040	14.9	5.7	54

TABLE A-21

CONTINUOUS GROUND DATA

CANTON, OHIO

July 21, 1974

	GAS DATA						MET. DATA					
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	7	11	38	.2	1.0	1.8	0	1	051	14.0	5.6	57
0200	14	8	24	.2	.9	1.8	0	1	047	13.0	5.8	61
0300	15	4	23	.1	.8	1.8	0	1	047	12.7	5.9	63
0400	14	6	24	.2	.9	1.8	0	1	041	12.4	6.0	65
0500	12	4	25	.2	1.0	1.8	0	4	049	12.2	6.0	66
0600	-	4	28	.2	1.1	1.9	0	4	053	11.8	5.8	66
0700	11	10	29	.2	1.1	1.8	32	6	038	11.7	5.9	67
0800	14	13	23	.2	1.0	1.8	247	6	055	13.3	6.5	63
0900	18	18	21	.1	.9	1.7	540	10	080	16.0	7.4	56
1000	26	11	16	.1	.8	1.7	840	6	084	18.9	8.3	50
1100	29	9	12	.1	.7	1.6	1101	5	093	20.9	9.0	47
1200	34	10	10	.1	.7	1.6	1318	8	089	22.2	8.8	42
1300	42	7	11	.1	.7	1.6	1457	10	101	23.2	8.5	39
1400	48	6	11	.1	.7	1.6	1490	8	120	25.1	8.9	36
1500	55	6	9	.1	.7	1.6	1446	9	085	25.3	9.0	35
1600	58	5	15	.1	.7	1.6	1352	9	103	26.3	8.9	33
1700	57	5	8	.1	.7	1.6	1159	9	070	26.0	8.8	33
1800	58	7	16	.1	.7	1.6	917	8	102	26.2	8.6	33
1900	52	8	24	.1	.8	1.6	653	9	057	26.1	8.8	33
2000	47	7	25	.1	1.1	1.6	274	9	074	25.3	7.9	33
2100	8	26	87	.3	1.6	1.7	89	5	079	23.3	7.5	36
2200	0	58	91	.4	2.2	1.8	0	2	083	20.3	7.8	44
2300	18	10	50	.2	1.1	1.8	0	2	045	18.6	7.1	47
2400	16	10	36	.1	1.1	1.8	0	2	052	16.8	8.1	57

TABLE A-22

CONTINUOUS GROUND DATA

CANTON, OHIO

July 22, 1974

	GAS	DATA					MET.	DATA				
Time	O_3	NO	NO_2	NMTHC	CO	CH_4	RAD	WS	WD	TMP	DP	RH
hr	ppb	ppb	ppb	ppm	ppm	ppm	mLy	mph	deg	°C	°C	%
0100	15	8	32	.1	1.0	1.8	0	1	056	15.4	8.2	62
0200	4	11	47	.2	1.0	1.9	0	1	064	14.3	8.0	66
0300	3	11	48	.2	1.0	1.9	0	1	072	13.7	8.0	68
0400	1	14	60	.3	1.1	1.9	0	1	085	13.5	8.0	70
0500	1	10	50	.3	1.2	2.0	0	1	084	13.3	8.0	70
0600	-	73	68	.4	1.8	2.1	0	1	081	13.1	7.7	70
0700	1	58	57	.6	2.3	2.3	32	1	091	13.5	7.4	67
0800	7	56	60	.6	2.6	2.2	254	1	095	15.4	8.2	62
0900	19	27	47	.4	1.5	2.0	511	3	162	19.2	9.2	52
1000	28	24	49	.5	1.6	2.2	675	1	166	21.4	9.8	47
1100	46	15	40	.4	1.4	1.9	779	1	147	23.4	10.4	44
1200	57	12	19	.1	1.0	1.9	1183	1	090	25.3	10.7	40
1300	64	6	16	.1	.8	1.7	1414	4	189	27.1	10.8	36
1400	73	6	14	.1	.9	1.7	1321	4	192	27.9	10.3	33
1500	81	6	13	.1	.9	1.7	1250	8	156	28.5	10.5	33
1600	79	6	11	.1	.9	1.7	1222	6	174	28.5	10.9	33
1700	74	6	13	.1	.9	1.7	829	6	175	28.5	10.8	33
1800	74	8	19	.1	.9	1.8	311	3	191	26.8	10.7	36
1900	68	6	18	.2	1.1	1.8	170	6	179	25.7	11.0	40
2000	50	8	36	.4	1.3	2.0	51	5	169	25.1	10.1	39
2100	40	7	44	.6	1.4	2.2	3	4	173	24.2	11.0	43
2200	46	7	30	.6	1.1	2.4	0	3	167	23.2	11.0	46
2300	41	9	40	.7	1.2	2.5	0	1	175	24.4	11.1	49
2400	53	9	29	.6	1.3	2.3	0	1	176	21.8	11.4	51

TABLE A-23

CONTINUOUS GROUND DATA

CANTON, OHIO

July 23, 1974

	GAS DATA						MET. DATA					
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	26	13	29	.3	1.0	1.9	0	1	055	21.3	11.6	54
0200	34	16	17	.1	.9	1.7	0	4	073	18.9	12.1	65
0300	29	17	13	.1	.8	1.7	0	6	073	17.6	12.1	70
0400	27	17	14	.1	.9	1.7	0	5	045	17.3	12.5	73
0500	29	17	15	.1	1.0	1.7	0	7	052	17.0	12.2	73
0600	-	19	28	.1	1.1	1.7	0	6	071	16.8	12.2	74
0700	15	19	34	.2	1.7	1.8	0	8	066	16.8	12.2	74
0800	6	23	45	.3	1.7	1.9	3	8	094	16.9	12.3	74
0900	7	32	28	.6	1.5	2.0	14	5	105	17.1	12.7	75
1000	11	25	26	.3	1.1	2.0	66	8	119	17.5	13.0	75
1100	13	25	30	.3	1.2	1.9	123	8	111	18.0	13.4	75
1200	13	24	29	.3	1.3	2.0	125	6	108	18.3	13.9	76
1300	18	28	28	.4	1.5	2.0	209	1	107	19.4	14.9	75
1400	18	33	53	.6	1.8	2.0	254	1	189	20.3	15.1	72
1500	27	32	52	.5	1.8	1.9	264	1	268	21.1	15.5	71
1600	41	23	26	.4	1.1	1.8	398	1	004	22.2	15.6	66
1700	31	27	61	.3	1.2	1.8	164	3	016	21.9	15.0	65
1800	46	27	28	.2	1.1	1.8	180	3	005	21.8	14.7	64
1900	25	33	50	.3	1.4	1.8	74	6	020	21.3	14.5	65
2000	23	29	56	.3	1.2	1.8	44	7	037	20.8	14.3	67
2100	26	25	32	.2	1.2	1.7	8	7	032	19.5	13.5	68
2200	26	27	37	.2	1.2	1.8	0	2	041	18.9	12.9	68
2300	22	28	40	.2	1.1	1.8	0	1	038	18.6	13.1	70
2400	22	29	38	.3	1.2	1.8	0	1	017	17.8	12.7	72

TABLE A-24

CONTINUOUS GROUND DATA

CANTON, OHIO

July 24, 1974

	GAS	DATA					MET.	DATA				
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	23	29	42	.3	1.0	1.8	0	1	355	17.0	12.4	74
0200	27	25	26	.3	1.0	1.8	0	1	341	16.3	11.9	75
0300	26	23	28	.3	1.0	1.8	0	1	358	16.0	11.5	75
0400	24	23	27	.4	1.0	1.8	0	1	008	15.6	11.4	76
0500	26	21	18	.3	.9	1.8	0	1	021	15.8	11.8	77
0600	18	19	15	.2	1.3	1.8	0	1	039	15.5	11.5	77
0700	9	20	29	.3	1.1	1.8	7	6	046	15.2	11.1	77
0800	20	25	30	.3	1.0	1.7	81	1	005	15.6	11.7	78
0900	28	22	26	.3	1.0	1.7	444	4	018	16.7	12.8	78
1000	31	23	22	.3	.9	1.7	429	1	002	19.2	12.8	67
1100	40	21	15	.2	.9	1.7	833	2	321	20.1	12.5	62
1200	42	18	22	.3	.9	1.6	770	2	018	21.6	13.1	58
1300	51	18	11	.2	.9	1.7	933	4	358	23.1	13.4	54
1400	56	13	13	.3	.9	1.6	1273	6	008	23.8	13.1	51
1500	61	11	16	.4	.8	1.6	1371	4	359	24.3	12.8	48
1600	62	11	16	.3	.8	1.6	1305	2	358	24.8	12.5	46
1700	57	12	5	.3	.9	1.6	1055	5	001	25.2	12.0	44
1800	52	12	17	.4	.9	1.6	692	7	357	24.7	11.7	44
1900	49	11	29	.3	.9	1.6	546	12	007	23.8	11.5	46
2000	38	12	30	-	-	-	245	5	011	23.1	10.9	46
2100	21	22	41	.5	1.6	1.7	35	3	001	21.0	9.5	48
2200	5	50	85	.4	1.4	1.7	0	1	359	19.2	8.9	51
2300	3	57	79	.5	1.9	1.7	0	1	023	17.8	8.7	55
2400	0	78	71	.4	1.5	1.7	0	1	038	15.9	8.4	61

TABLE A-25

CONTINUOUS GROUND DATA

CANTON, OHIO

July 25, 1974

	GAS DATA						MET. DATA					
Time hr	O_3 ppb	NO ppb	NO_2 ppb	NMTHC ppm	CO ppm	CH_4 ppm	RAD mLy	WS mph	WD deg	TMP °C	DP °C	RH %
0100	1	50	69	.6	2.2	1.9	0	1	066	14.9	8.3	65
0200	0	112	66	1.3	2.5	2.2	0	1	085	13.5	8.3	71
0300	0	70	53	1.2	1.5	2.2	0	1	092	13.1	8.6	74
0400	4	24	60	.4	1.0	1.9	0	1	041	13.4	8.7	73
0500	4	15	61	.5	1.2	2.1	0	1	042	12.8	8.8	74
0600	2	99	40	.6	1.6	1.9	0	1	079	12.5	8.3	76
0700	5	90	57	.8	3.1	2.2	13	1	070	12.9	8.6	75
0800	0	124	46	1.3	4.0	2.9	154	1	143	13.4	9.0	75
0900	10	65	59	.7	1.5	2.2	454	1	126	17.8	10.8	63
1000	38	15	22	.4	.9	1.8	799	1	099	21.0	11.8	55
1100	49	12	14	.2	.8	1.7	1054	4	111	22.9	11.9	50
1200	54	11	16	.2	.8	1.7	1212	4	113	24.8	12.6	47
1300	55	9	11	.2	.8	1.7	1206	3	048	25.3	12.3	44
1400	54	8	11	.2	.8	1.7	1291	5	036	26.0	11.8	41
1500	59	8	3	.2	.8	1.6	1165	3	043	26.4	11.5	39
1600	61	8	11	.2	.8	1.6	1164	2	100	27.5	10.9	35
1700	63	10	16	.2	.8	1.6	835	1	102	26.3	10.9	38
1800	62	8	13	.2	.8	1.6	631	1	025	26.0	10.8	39
1900	55	8	37	.3	1.2	1.7	314	1	045	25.0	10.5	40
2000	44	12	38	.4	1.5	1.7	126	1	050	23.9	10.7	43
2100	20	13	77	.6	2.3	1.8	21	1	072	22.7	10.9	47
2200	3	23	112	.9	2.8	1.9	0	1	086	21.6	11.0	51
2300	19	30	71	.4	1.5	1.8	0	1	070	20.5	11.0	54
2400	15	21	69	.5	1.7	1.8	0	1	053	19.2	11.3	60

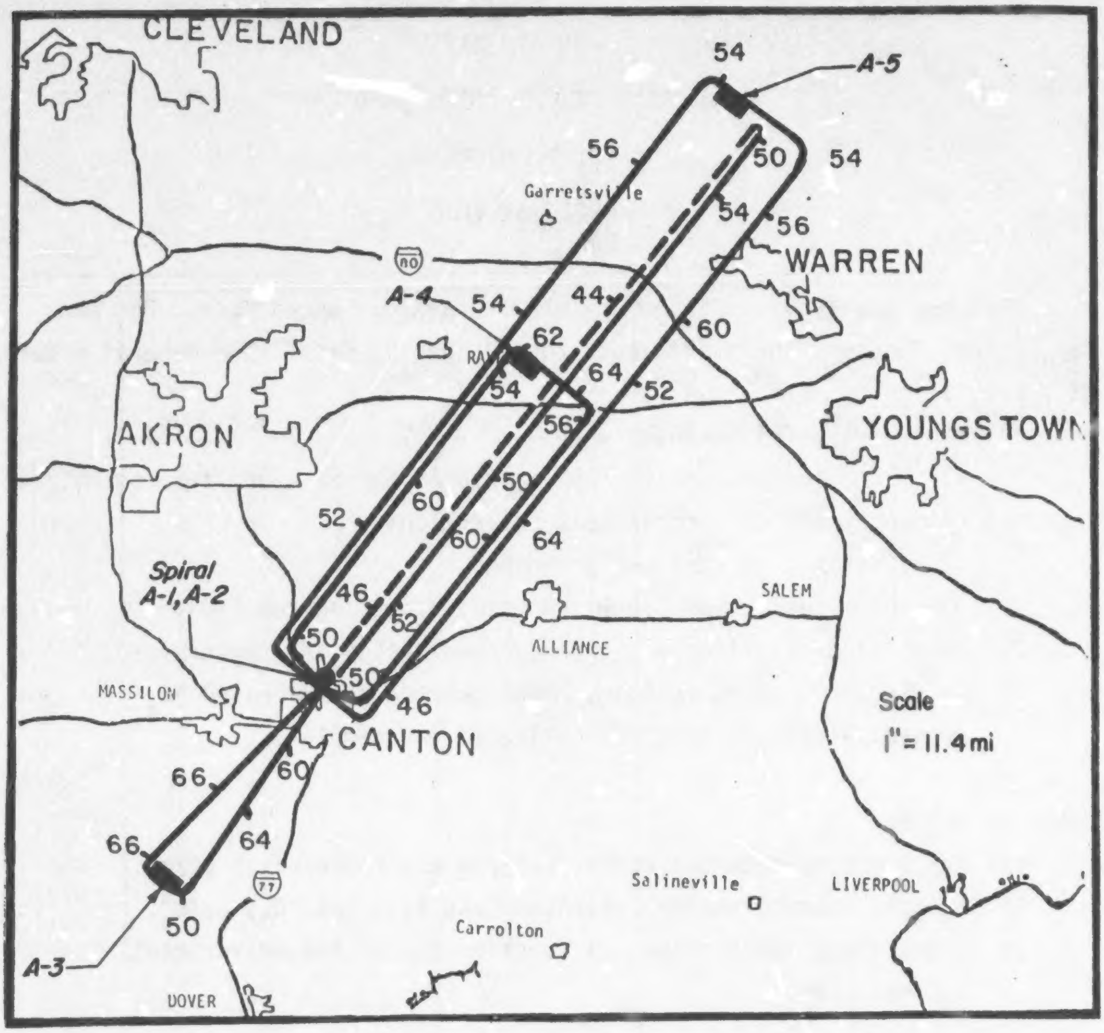
APPENDIX B

This section provides a summary of aircraft collected data. For each day, except Sundays, there are about three pages of data. The general order of presentation is as follows:

1) Map showing flight paths with:
   a) ozone concentrations (ppb marked at points along the route),
   b) locations of aircraft bag collections,
   c) locations of vertical soundings,
   d) and locations of touch and go landings (marked T/G).
2) Graph(s) of altitude vs. ozone concentration and temperature.
3) Light hydrocarbon, methane, NMTHC, carbon monoxide and NO_x concentrations in aircraft collected bag samples.

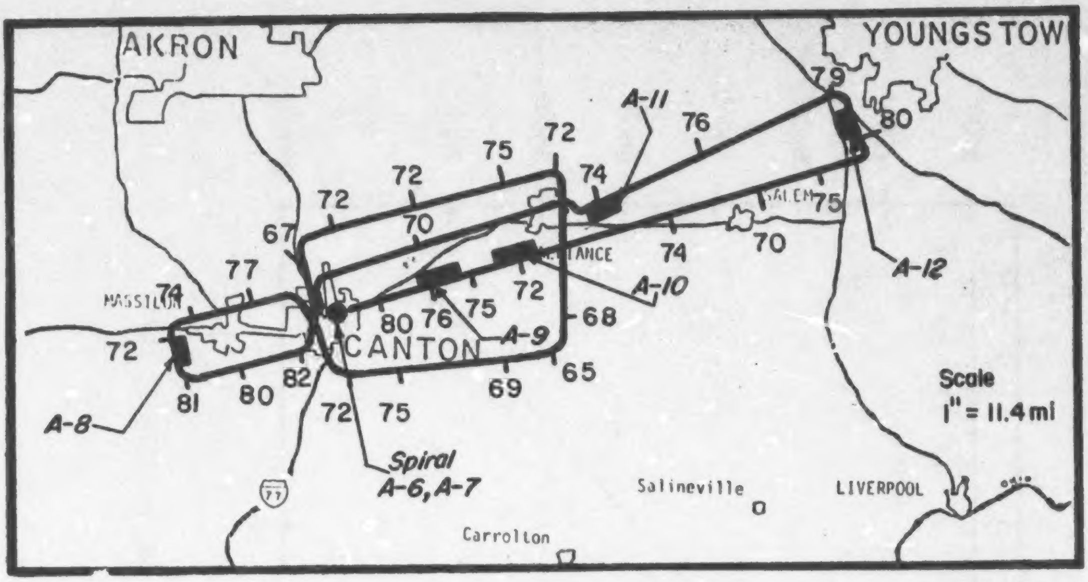
Notes on Tables:

1) All light hydrocarbon concentrations are reported as $\mu g/m^3$.
2) * means hydrocarbon concentration was less than 0.5 $\mu g/m^3$.
3) Blank space means value was questionable or the measurement was not made.


CLEVELAND
54
A-5
56
50
54
Garretsville
54
56
WARREN
80
A-4
54
44
60
62
RAV
54
64
52
AKRON
56
YOUNGSTOWN
50
60
52
60
64
Spiral A-1, A-2
46
52
SALEM
50
ALLIANCE
50
MASSILON
46
Scale
1" = 11.4 mi
CANTON
66
60
66
64
77
Salineville
LIVERPOOL
50
Carrolton
A-3
DOVER

Time:	8:00 am to 10:36 am
Leg:	8:05 - 9:06 Center upwind
	9:06 - 9:22 Upwind loop
	9:22 - 10:06 Long downwind
	10:06 - 10:36 Short downwind
Wind:	230° at 9 mph
Weather:	Sunny with ground haze
Comments:	Dotted line is path at 4000'; solid line is at 1000'

Figure B-1. Morning flight path on July 1, 1974.


AKRON
YOUNGSTOW
A-11
79
80
76
72
75
72
74
SALEM
75
72
70
67
70
74
77
ALLIANCE
74
70
A-12
A-10
MASSILLON
74
72
80
76
75
72
68
A-9
CANTON
72
65
A-8
81
80
82
72
75
69
Spiral
A-6, A-7
Scale
1" = 11.4 mi
77
Salineville
LIVERPOOL
Carrollton

Time: 1:00 pm to 3:05 pm
Leg: 1:40 - 2:10 Short downwind
2:10 - 2:21 Upwind loop
2:21 - 3:00 Long downwind
Wind: 260° at 14 mph
Weather: Clear and warm
Comments: Flight altitude - 1000'

Figure B-2. Afternoon flight path on July 1, 1974.

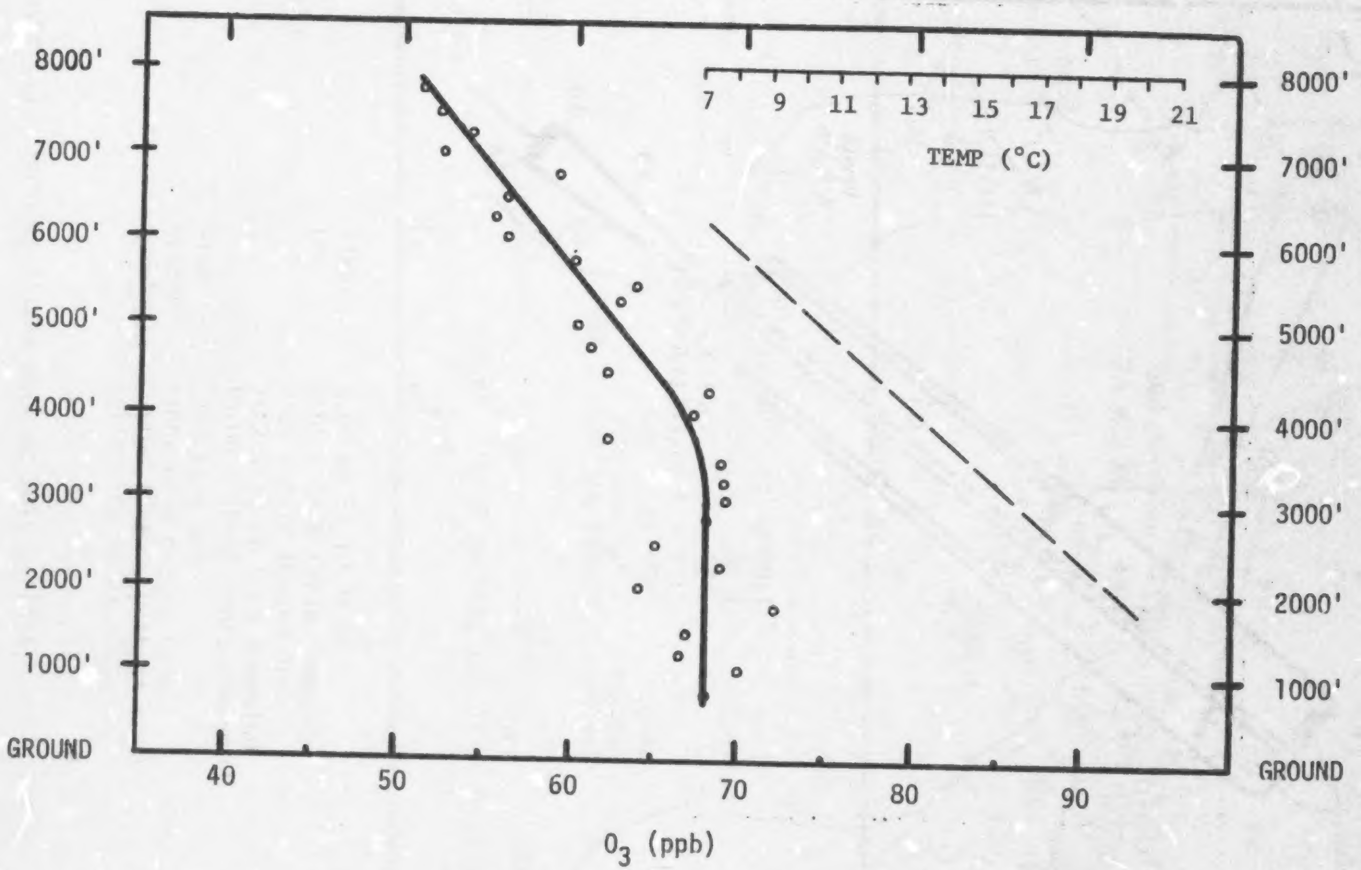


Figure B-3. Spiral climb over Malone College (1:38 pm) on July 1, 1974.

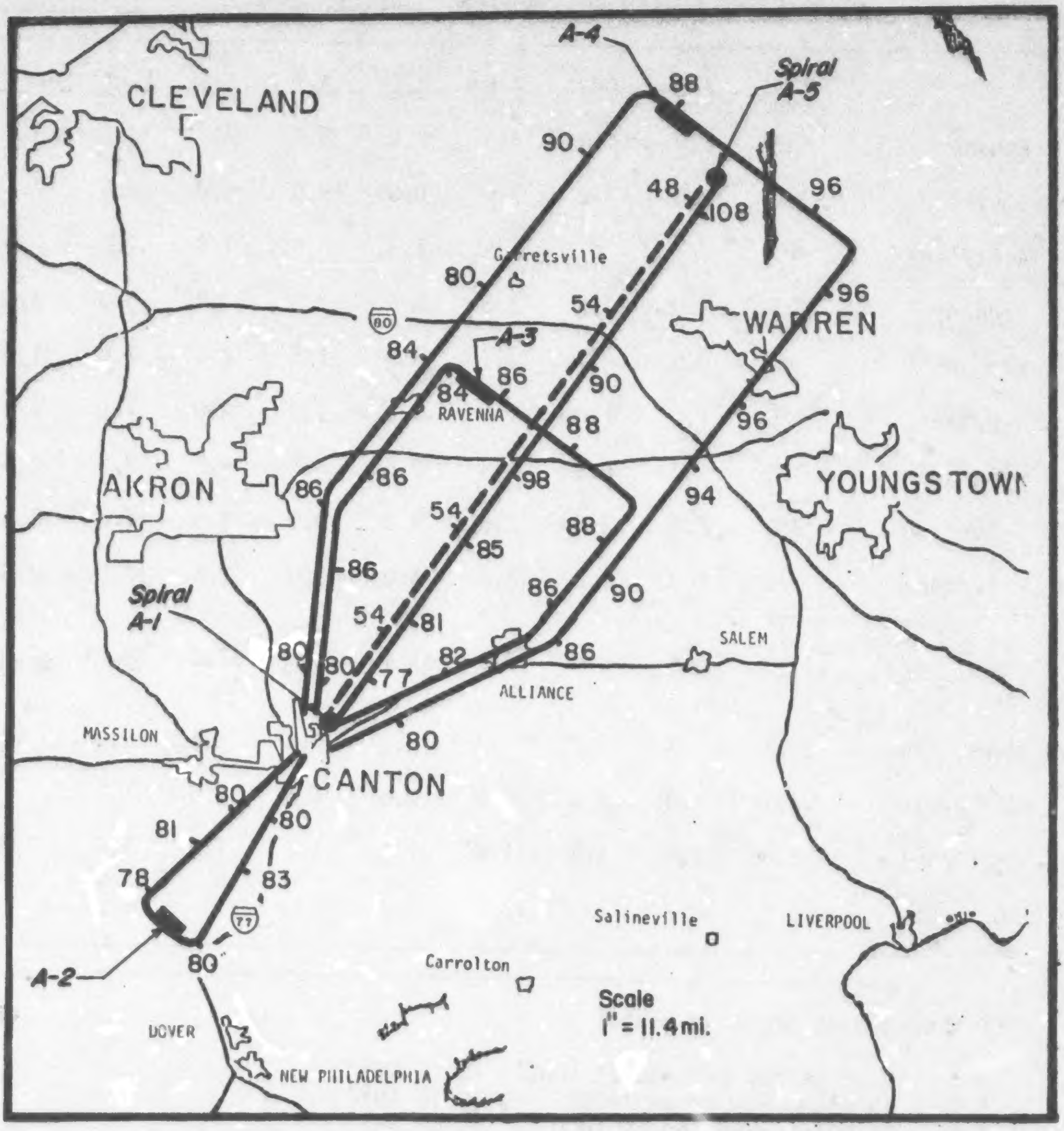
TABLE B-1. AIRCRAFT COLLECTED BAG SAMPLES. JULY 1, 1974.

	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-11	A-12
Ethane	5.5	6.0	4.0	7.5	7.5	5.0	7.5	6.5	5.5
Ethylene	3.0	3.0	3.0	3.0	9.0	5.0	8.0	12.0	7.0
Acetylene	*	*	*	.5	1.5	.5	1.0	1.0	.5
Propane	2.5	3.0	2.5	3.5	5.0	2.5	.45	3.0	3.0
Propene	*	.5	*	.5	3.5	1.5	2.0	1.0	1.0
i-Butane	1.5	1.0	1.0	1.5	3.0	1.0	2.0	1.5	2.0
n-Butane	3.0	3.0	2.5	3.5	9.5	3.5	4.5	3.5	4.5
i-Pentane	3.0	2.0	2.0	2.5	8.0	6.0	5.5	7.5	11.5
n-Pentane	1.0	1.0	1.0	1.0	4.0	2.0	2.5	2.0	2.5
Total $\mu g/m^3$	19.5	19.5	16.0	23.5	51.0	28.0	37.5	38.0	37.5
NMTHC (ppm)	.3	.3	.3	.3	.5	.6	.6	.4	.4
CO (ppm)	1.1	1.0	1.0	1.0	2.6	1.6	1.0		
CH_4 (ppm)	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
NO_x (ppb)	13	10	11	12					

KEY (see map on previous page):

A-2	Over Malone College at 4000'	(8:15 AM)
A-3	16 miles upwind at 1000'	(9:15 AM)
A-4	26 miles downwind at 1000'	(9:40 AM)
A-5	52 miles downwind at 1000'	(10:20 AM)
A-6	Over Malone College at 1000'	(1:00 PM)
A-7	Over Malone College at 7500'	(1:25 PM)
A-8	14 miles upwind at 1000'	(2:15 PM)
A-11	18 miles downwind at 1000'	(2:30 PM)
A-12	35 miles downwind at 1000'	(2:40 PM)

A-1,9,10 - Analysis Incomplete


CLEVELAND
A-4
88
Spiral
A-5
90
48
108
96
Garretsville
80
54
96
80
WARREN
84
A-3
86
84
90
RAVENNA
88
96
AKRON
86
86
98
94
YOUNGSTOWN
54
88
85
86
86
90
Spiral
A-I
54
81
SALEM
80
80
82
86
77
ALLIANCE
MASSILON
80
CANTON
80
80
81
83
78
77
Salineville
LIVERPOOL
A-2
80
Carrolton
Scale
1" = 11.4 mi.
DOVER
NEW PHILADELPHIA

Time: 9:10 am - 12:05 pm

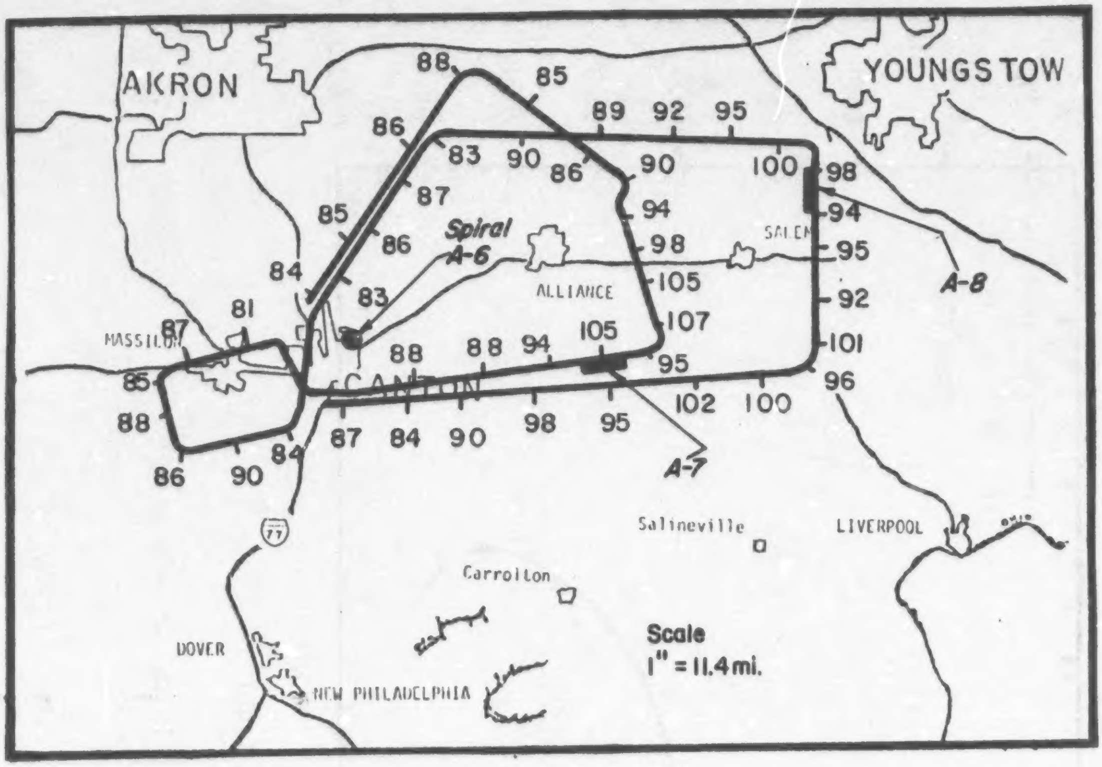
Leg: 9:10 - 10:26 Center downwind
10:26 - 10:41 Upwind loop
10:41 - 11:40 Long downwind
11:40 - 12:05 Short downwind

Wind: 240° at 12 mph

Weather: Sunny and cool

Comments: Dotted line is path at 5000'; solid line at 1000'.

Figure B-4. Morning flight path on July 2, 1974.


AKRON
YOUNGSTOW
Spiral A-6
ALLIANCE
SALEM
A-8
MASSILON
CANTON
A-7
77
Salineville
LIVERPOOL
Carrollton
DOVER
NEW PHILADELPHIA
Scale
1" = 11.4 mi.

Time: 2:00 pm to 4:15 pm
Leg: 2:20 - 3:00 Short downwind
3:00 - 3:20 Upwind loop
3:20 - 4:15 Long downwind
Wind: 240° at 11 mph
Weather: Cloudy, hot, and hazy
Comments: Flight altitude - 1000'

Figure B-5. Afternoon flight path on July 2, 1974.

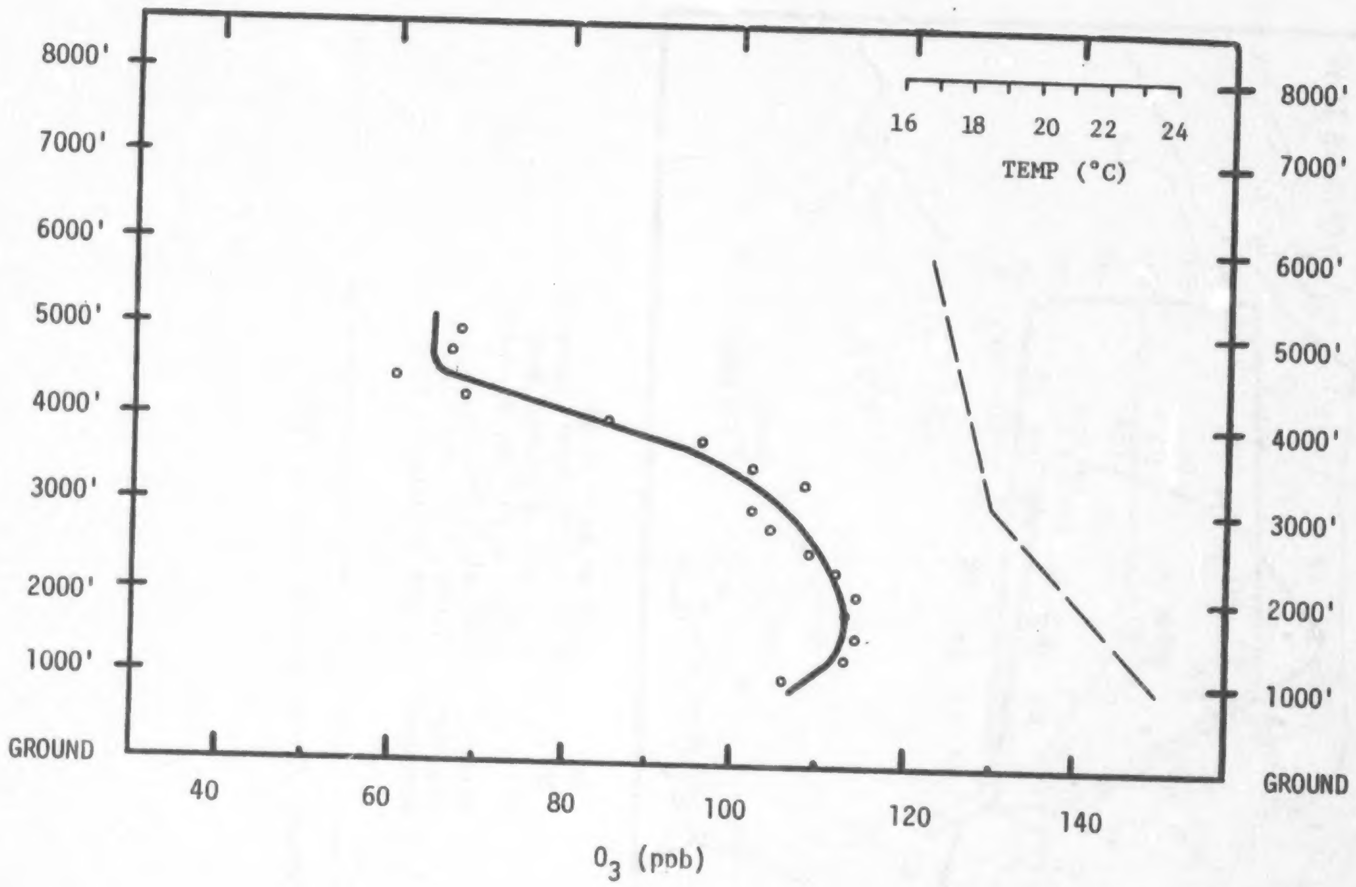


Figure B-6. Spiral climb over Malone College (9:15 am) on July 2, 1974.

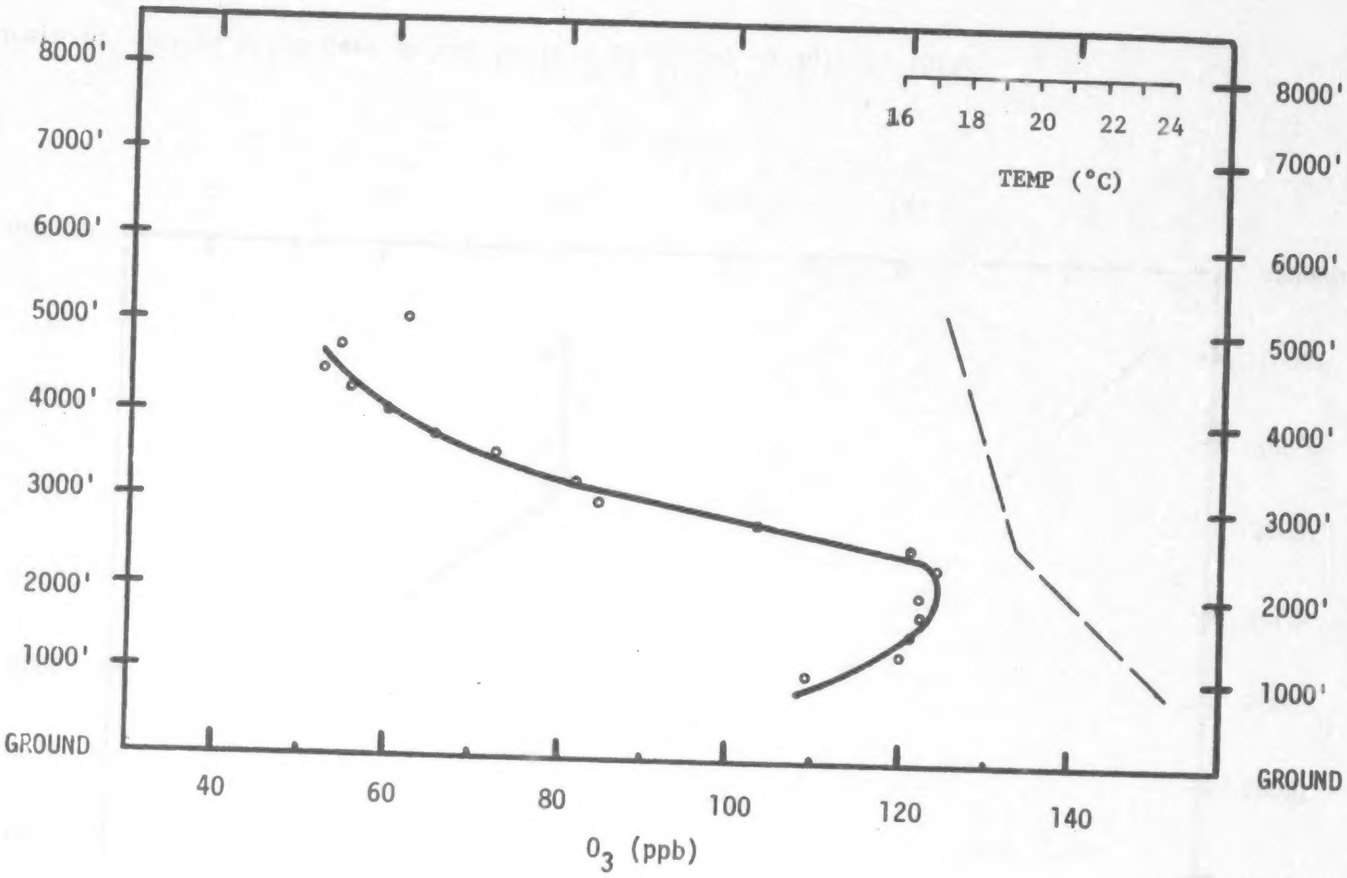


Figure B-7. Spiral descent - 50 miles downwind (9:51 am) on July 2, 1974.

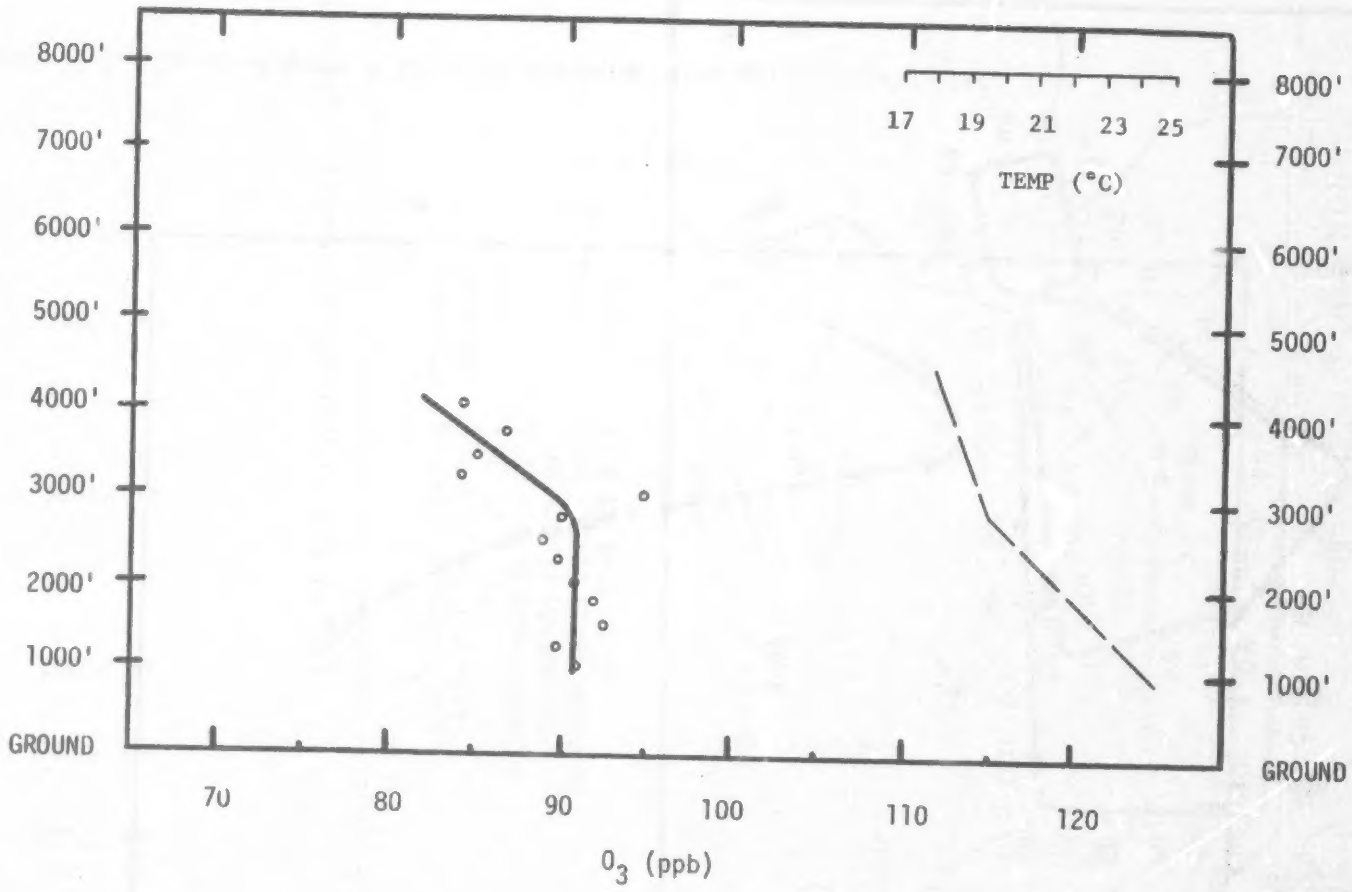


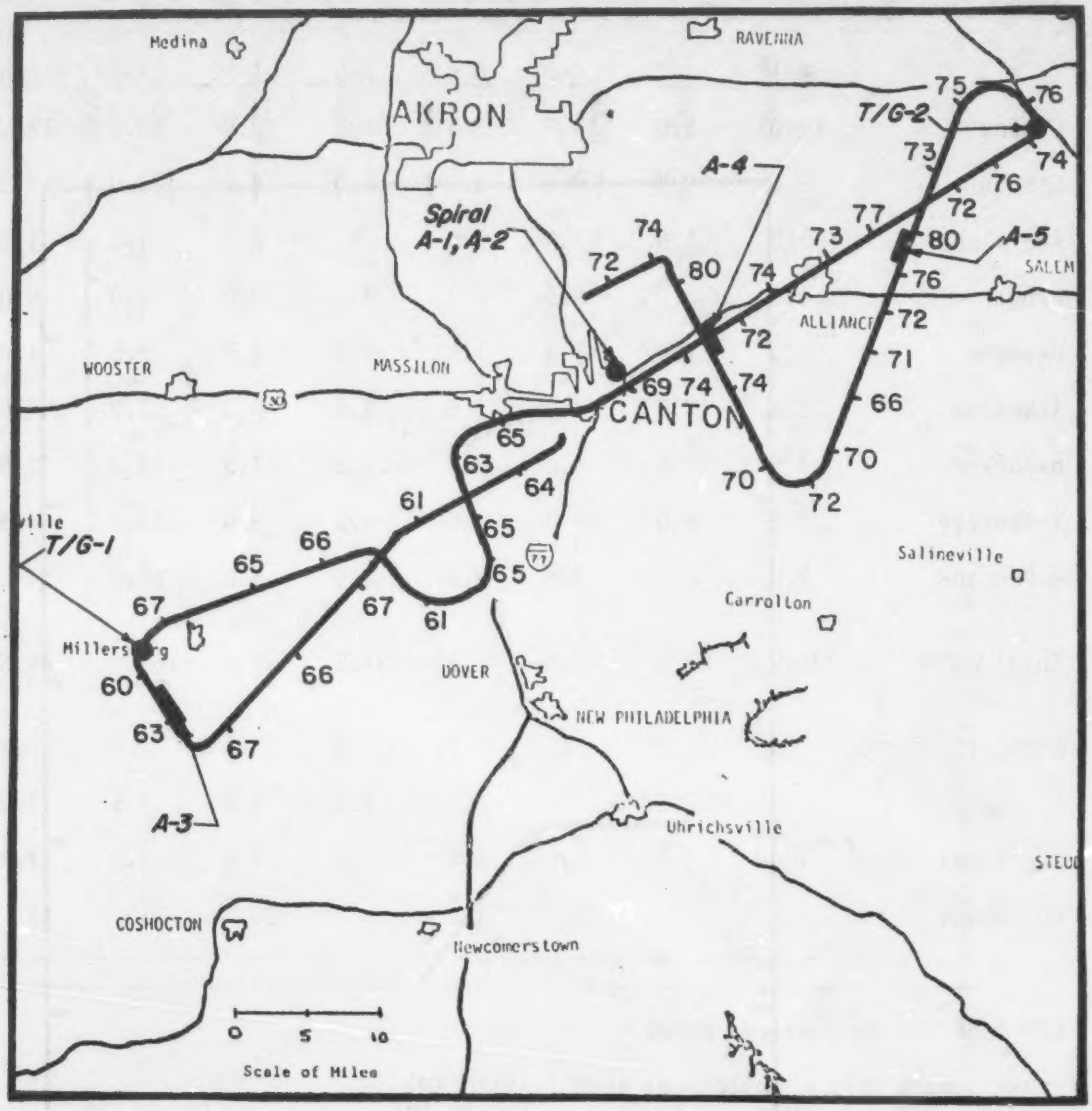
Figure B-8. Spiral climb over Malone College (2:13 pm) on July 2, 1974.

TABLE B-2. AIRCRAFT COLLECTED BAG SAMPLES. JULY 2, 1974.

	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8
Ethane	10.0	13.0	14.5	7.5	6.5	13.0	13.0	13.5
Ethylene	6.0	5.5	8.0	3.0	6.0	4.0	23.0	4.5
Acetylene	1.0	1.5	1.5	1.5	*	2.0	4.0	1.5
Propane	5.5	8.0	9.5	7.5	3.5	10.0	9.0	9.0
Propene	.5	1.0	1.5	1.5	2.0	1.0	3.5	1.0
i-Butane	2.5	3.5	4.0	3.5	2.0	5.5	13.0	4.0
n-Butane	4.5	6.5	8.0	7.5	4.5	11.5	32.0	8.5
i-Pentane	4.5	6.0	9.0	7.0	4.5	8.0	45.0	4.5
n-Pentane	2.0	2.5	3.5	3.5	2.5	4.0	20.0	3.0
Total $\mu g/m^3$	36.5	47.5	59.5	42.5	31.5	59.0	163	49.5
NMTHC (ppm)	.3	.4	.5	.7	.4	.3	.7	.2
CO (ppm)		2.6		2.2	2.0	1.2	1.5	1.0
CH_4 (ppm)	1.8	1.8	1.8	1.7	1.6	1.8	2.0	1.8
NO_x (ppb)						20	31	16

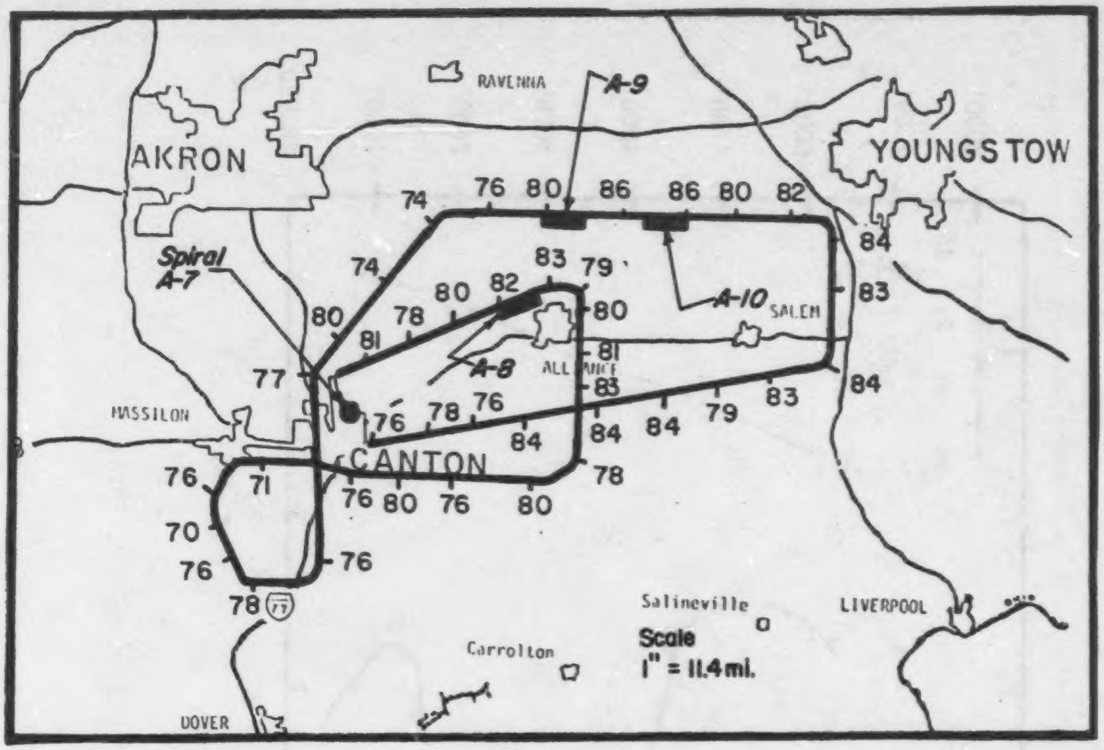
KEY (see map on previous page):

A-1	Over Malone College at 1000'	(9:15 AM)
A-2	16 miles upwind at 1000'	(10:40 AM)
A-3	19 miles downwind at 1000'	(11:50 AM)
A-4	44 miles downwind at 1000'	(11:05 AM)
A-5	48 miles downwind at 5000'	(9:40 AM)
A-6	Over Malone College at 1000'	(2:15 PM)
A-7	18 miles downwind at 1000'	(2:50 PM)
A-8	33 miles downwind at 1000'	(3:45 PM)


Medina
RAVENNA
AKRON
T/G-2
A-4
Spiral A-1, A-2
A-5
SALEM
ALLIANCE
WOOSTER
MASSILON
CANTON
ville
T/G-1
Salineville
Carrollton
Millersburg
DOVER
NEW PHILADELPHIA
A-3
Uhrichsville
STEU
COSHOCTON
Newcomerstown
0 5 10
Scale of Miles
75
76
73
74
76
77
72
73
80
74
72
80
74
76
72
72
71
69
74
74
66
65
70
70
72
63
64
61
65
66
65
65
67
67
61
60
66
63
67

Time: 9:25 am to 11:55 am
Leg: 10:02 - 10:54 Upwind loop 10:54 - 11:55 Downwind loop
Wind: 250° at 11 mph Weather: Sunny with light haze
Comments: Flight altitude - 1000'

Figure B-9. Morning flight path on July 3, 1974.


RAVENNA
A-9
AKRON
YOUNGSTOW
Spiral A-7
A-8
A-10
SALEM
ALLIANCE
MASSILON
CANTON
Salineville
LIVERPOOL
Scale
1" = 11.4 mi.
Carrolton
DOVER
77

Time: 1:30 pm - 3:35 pm
Leg: 2:02 - 2:31 Short downwind
2:31 - 2:49 Upwind loop
2:49 - 3:35 Long downwind
Wind: 240° at 11 mph
Weather: Hot and hazy
Comments: Flight altitude - 1000'

Figure B-10. Afternoon flight path on July 3, 1974.

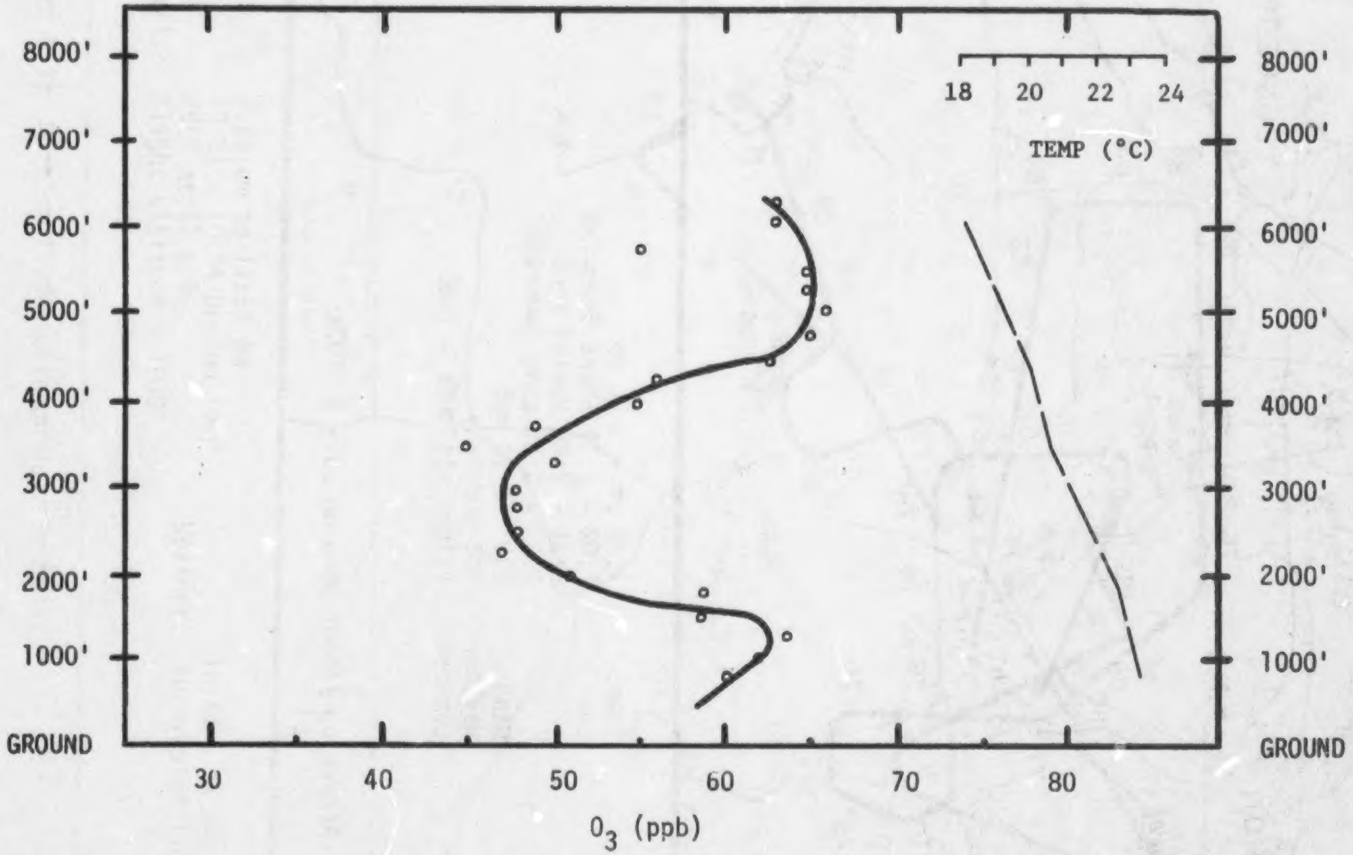


Figure B-11. Spiral climb over Malone College (9:47 am) on July 3, 1974.

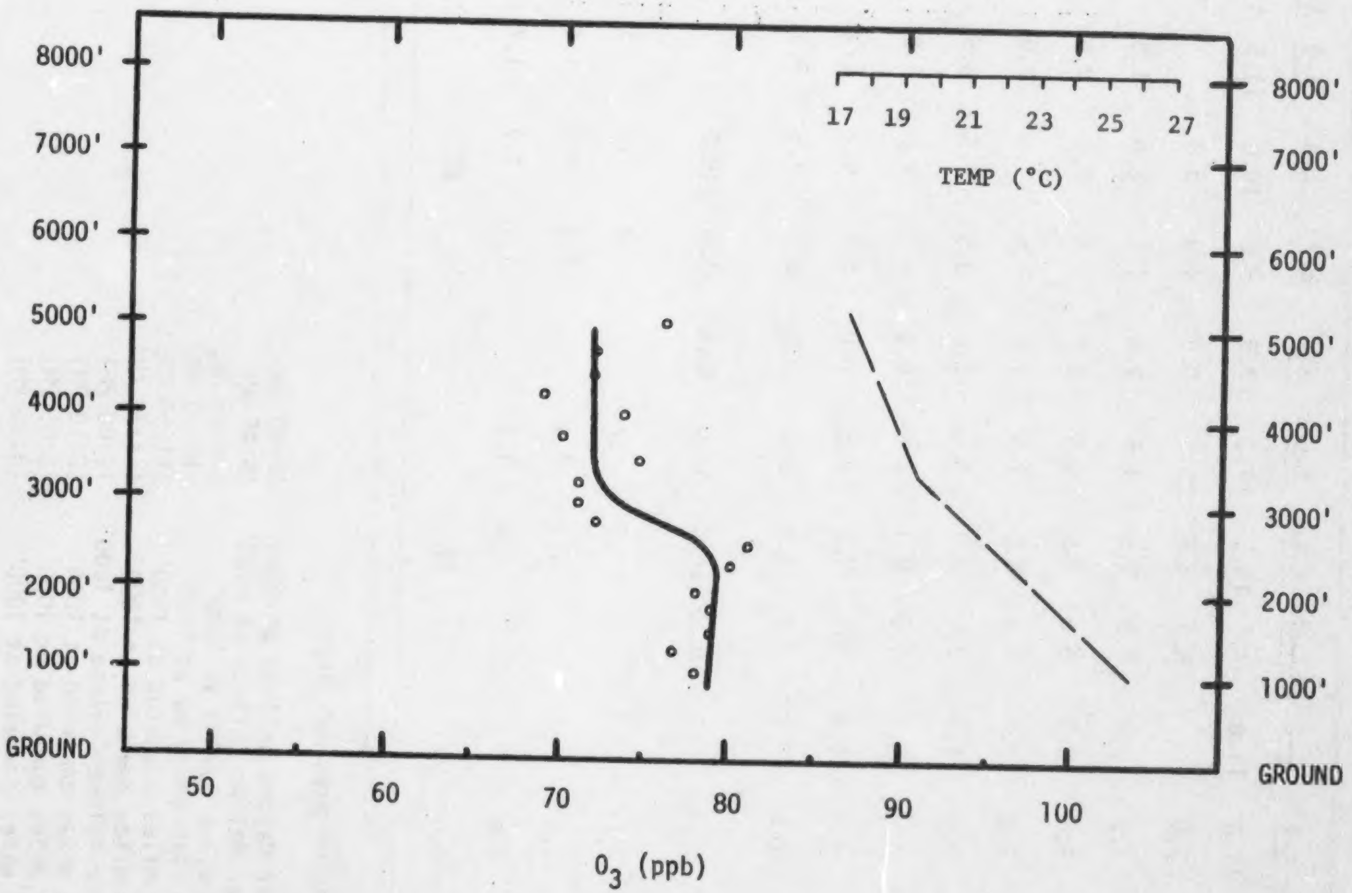


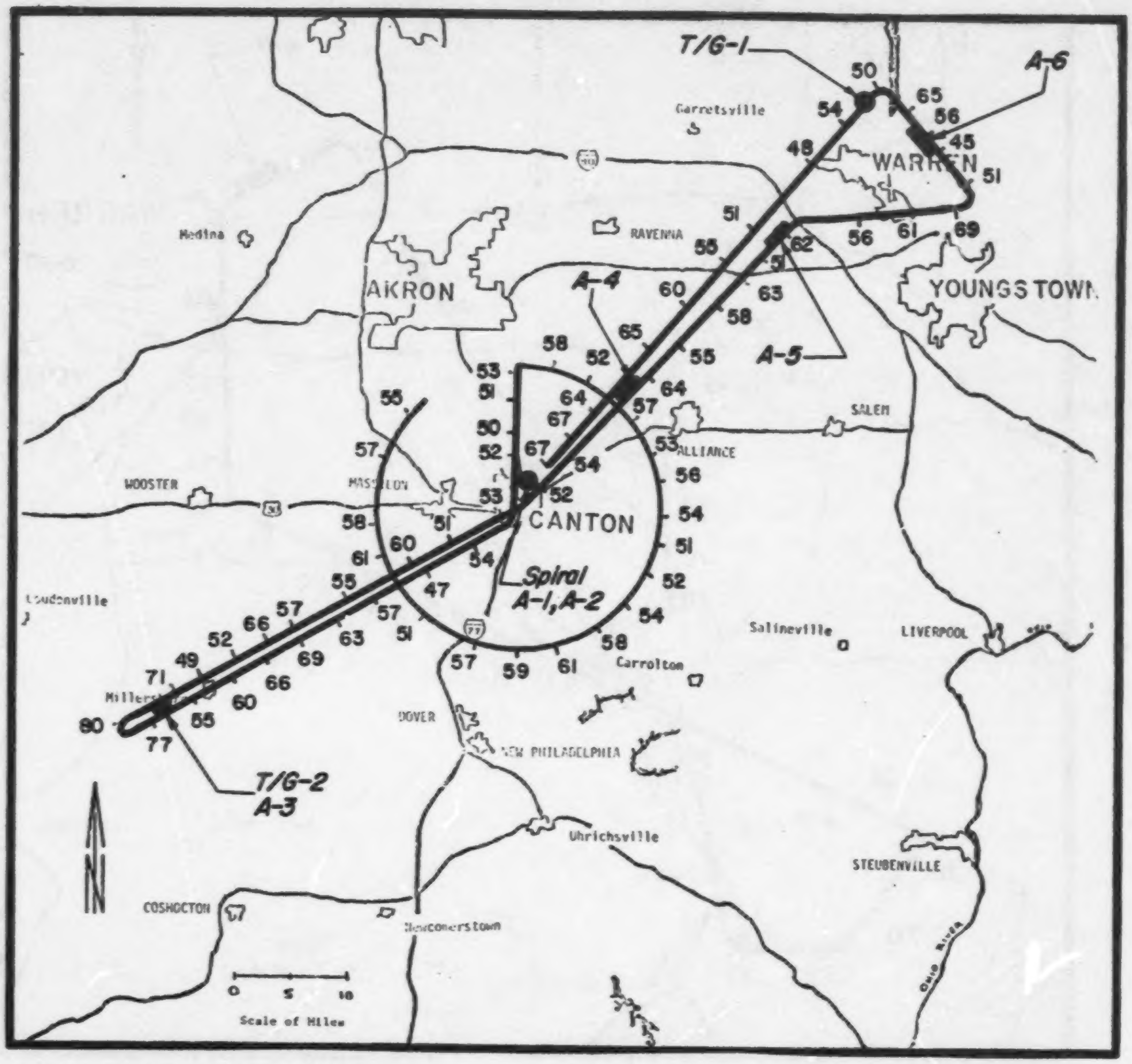
Figure B-12. Spiral climb over Malone College (1:56 pm) on July 3. 1974.

TABLE B-3. AIRCRAFT COLLECTED BAG SAMPLES. JULY 3, 1974.

	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10
Ethane	11.0	11.0	7.5	10.5	14.0	10.5	8.0	10.0	11.5	10.0
Ethylene	7.0		5.5	6.5	5.0	9.5	4.0	6.0		4.0
Acetylene	1.0	3.0	2.0	1.5	1.5	2.5	1.5	2.0	1.5	1.0
Propane	7.5	6.0	5.0	7.5	9.5	6.5	5.5	7.5	7.5	7.0
Propene	1.5	3.0	1.5	1.0	1.5	1.5	1.5	1.5	3.0	3.5
i-Butane	2.5	1.5	2.5	9.0	3.0	3.0	3.5	3.5	3.5	9.0
n-Butane	4.5	3.5	4.5	9.0	6.0	6.5	7.5	9.0	8.5	9.5
i-Pentane	4.0	6.0	5.5	7.5	4.5	6.0	6.5	6.5	6.5	7.0
n-Pentane	2.5	2.0	2.0	3.5	3.0	2.5	3.5	3.5	3.5	4.0
Total $\mu g/m^3$	41.5		36.0	56.0	48.0	48.5	41.5	49.5		55.0
NMTHC (ppm)	.1			.2	.2		.2	.3	.5	.3
CO (ppm)	1.0			1.1	1.4		1.2	1.1	1.4	1.2
CH_4 (ppm)	1.8			1.8	1.9		1.7	1.7	1.7	1.7
NO_x (ppb)	20			19			18	22		15

KEY (see map on previous page):

A-1	Over Malone College at 1000'	(9:30 AM)
A-2	Over Malone College at 6000'	(9:45 AM)
A-3	40 miles upwind at 1000'	(10:25 AM)
A-4	5 miles downwind at 1000'	(10:00 AM)
A-5	18 miles downwind at 1000'	(11:35 AM)
A-6	35 miles downwind at 1000'	(11:20 AM)
A-7	Over Malone College at 1000'	(2:00 PM)
A-8	15 miles downwind at 1000'	(2:10 PM)
A-9	21 miles downwind at 1000'	(3:05 PM)
A-10	25 miles downwind at 1000'	(3:10 PM)


T/G-1
A-6
Garretsville
WARREN
Medina
RAVENNA
YOUNGSTOWN
AKRON
A-4
A-5
SALEM
ALLIANCE
WOOSTER
MASSILLON
CANTON
Spiral
A-1, A-2
Loudonville
Salineville
LIVERPOOL
Carrolton
Millersburg
DOVER
NEW PHILADELPHIA
T/G-2
A-3
Uhrichsville
STEUBENVILLE
COSHOCTON
Newcomerstown
Ohio River
N
0 5 10
Scale of Miles

Time: 7:15 am to 10:15 am

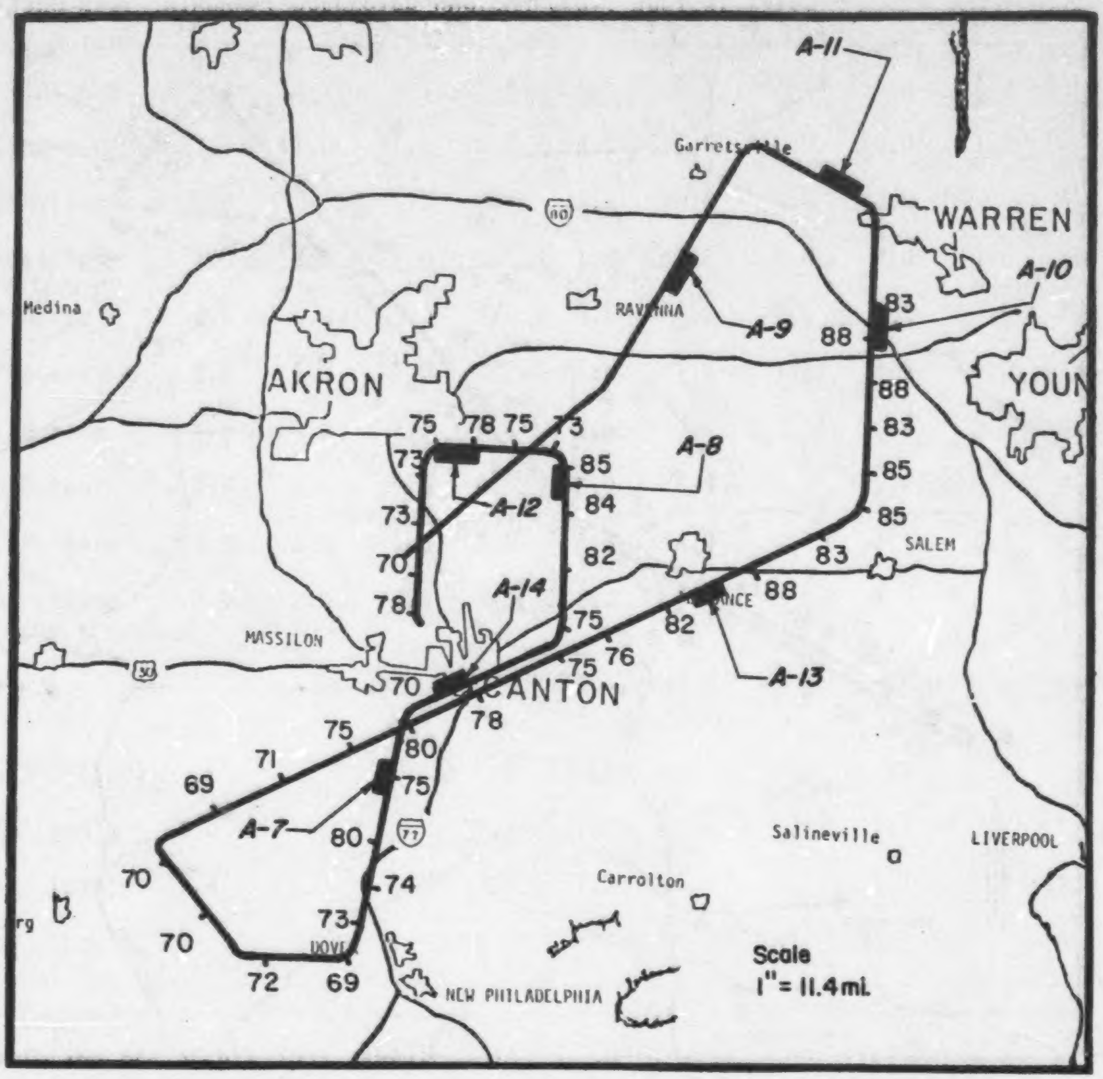
Leg: 7:50 - 8:44 Downwind loop
8:44 - 9:39 Upwind loop
9:39 - 10:15 City circle

Wind: 210° at 5 mph

Weather: Sunny with light ground haze

Comments: Flight altitude - 1000'

Figure B-13. Morning flight path on July 4, 1974.



A-11
Garrettsville
WARREN
A-10
83
88
Medina
RAVENNA
A-9
AKRON
YOUN
88
83
75
78
75
73
73
85
A-8
84
A-12
73
85
70
82
83
SALEM
A-14
78
88
MASSILON
75
82
30
75
76
A-13
70
CANTON
78
75
80
71
69
75
A-7
80
77
Salineville
LIVERPOOL
70
74
Carrolton
73
70
DOVER
72
69
NEW PHILADELPHIA
Scale
1" = 11.4 mi.
80

Time: 4:00 pm - 5:50 pm

Leg: 4:00 - 4:52 Long downwind
4:52 - 5:21 Upwind loop
5:21 - 5:50 Short downwind

Wind: 230° at 13 mph
Weather: Hot and very hazy
Comments: Flight altitude - 1000'

Figure B-14. Afternoon flight path on July 4, 1974.

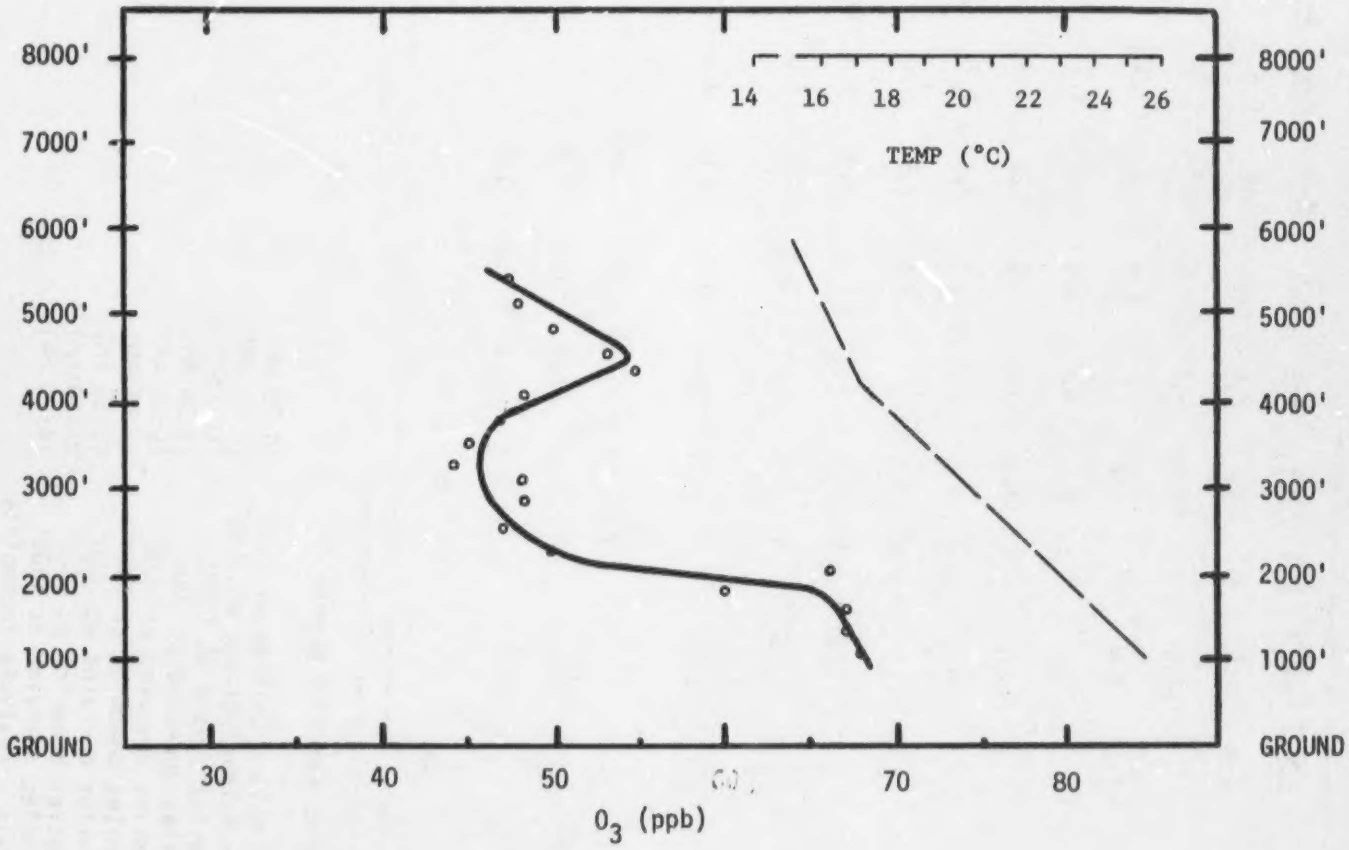


Figure B-15. Spiral climb over Malone College (7:44 am) on July 4, 1974.

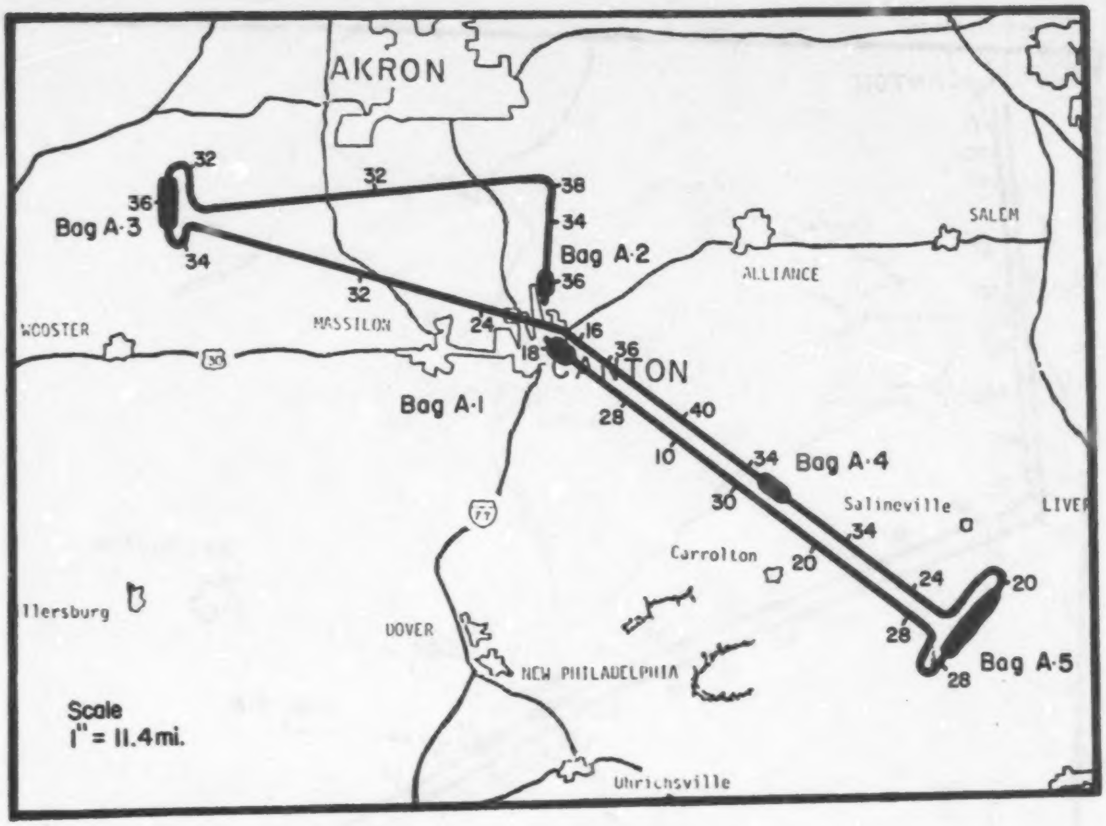
TABLE B-4. AIRCRAFT COLLECTED BAG SAMPLES. JULY 4, 1974.

	A-1	A-2	A-3	A-4	A-5	A-6	A-8	A-9	A-11
Ethane	8.0	8.0	9.0	10.0	2.5	7.5	9.0	9.5	9.5
Ethylene		10.0		10.5	4.5	5.5	5.5	2.5	5.0
Acetylene	1.0	2.0	*	.5	*	1.0	.5	.5	.5
Propane	5.0	6.0	5.5	6.0	4.0	5.5	5.5	5.5	5.5
Propene	.5	2.5	.5	1.0	1.0	1.0	1.5	1.0	1.5
i-Butane	2.0	2.5	1.5	2.0	2.0	3.0	3.5	2.5	2.0
n-Butane	3.0	4.5	2.5	5.0	2.5	5.5	7.5	5.0	4.5
i-Pentane	2.5	4.0	2.5	3.5	1.5	4.5	8.0	4.5	3.5
n-Pentane	1.5	2.5	1.0	2.0	.5	3.0	3.0	1.0	2.5
Total μg/m^3		42.0		40.5	18.0	36.5	44.0	32.0	34.5
NMTHC (ppm)	.3		.2	.3	.3	.3	.05		
CO (ppm)	.8		.7	1.1	1.0	1.0	.9		
CH_4 (ppm)	1.7		1.7	1.7	1.6	1.6	1.8		
NO_x (ppb)	16		16	20	16	17			

KEY (see map on previous page):

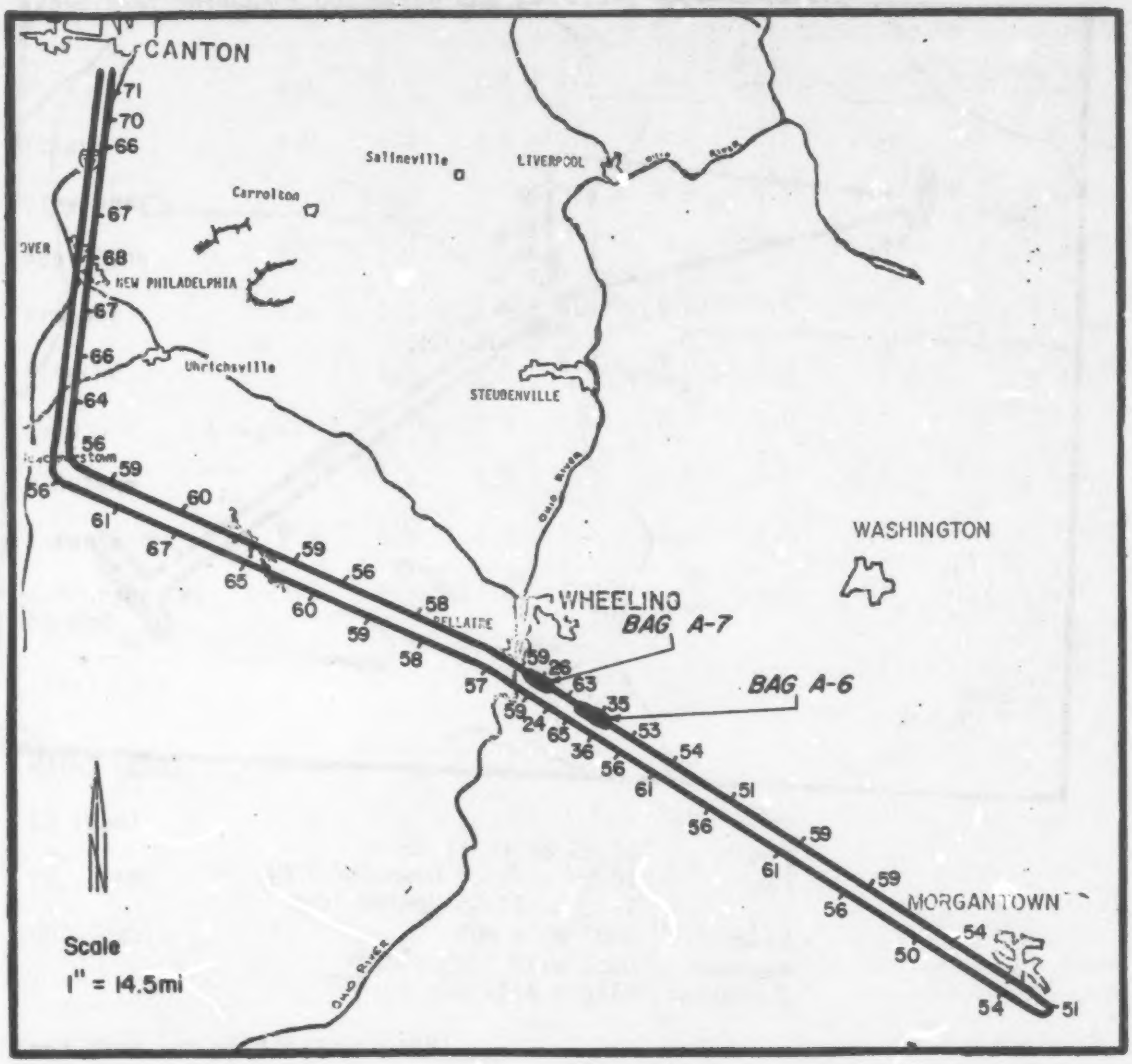
A-1	Over Malone College at 1000'	(8:20 AM)
A-2	Over Malone College at 5000'	(8:30 AM)
A-3	32 miles upwind at 1000'	(10:15 AM)
A-4	5 miles downwind at 1000'	(9:35 AM)
A-5	32 miles downwind at 1000'	(9:25 AM)
A-6	47 miles downwind at 1000'	(9:05 AM)
A-8	14 miles downwind at 1000'	(5:30 PM)
A-9	29 miles downwind at 1000'	(4:10 PM)
A-11	40 miles downwind at 1000'	(4:20 PM)

A-7,10,12-14 - Analysis Incomplete


AKRON
32
36
Bag A·3
34
32
38
34
Bag A·2
36
SALEM
ALLIANCE
32
MASSILON
WOOSTER
30
24
16
18
36
CANTON
Bag A·1
28
40
10
34
Bag A·4
30
Salineville
LIVER
34
77
Carrolton
20
24
20
28
Bag A·5
28
llersburg
DOVER
NEW PHILADELPHIA
Scale
1" = 11.4 mi.
Uhrichsville

Time: 10:45 am to 11:55 am
Leg: 10:50 - 11:28 Downwind loop
11:28 - 11:55 Upwind loop
Wind: 300° at 5 mph
Weather: Cool with high clouds
Comments: Flight altitude - 1000'

Figure B-16. Morning flight path on July 5, 1974.


CANTON
71
70
66
Salineville
LIVERPOOL
Carrolton
67
OVER
68
NEW PHILADELPHIA
67
66
Uhrichsville
64
STEUBENVILLE
56
59
56
61
60
67
65
59
56
60
59
58
BELLAIRE
58
57
WHEELING
BAG A-7
59
26
63
BAG A-6
35
59
24
65
53
36
54
56
61
51
56
59
61
59
56
MORGANTOWN
54
50
54
51
WASHINGTON
Ohio River
Ohio River
N
Scale
1" = 14.5mi

Time:	3:15 pm - 5:10 pm		
Leg:	4:10 Wheeling (Southbound)	Wind:	340° at 11 mph
	4:30 Morgantown	Weather:	Cool with rain
	4:50 Wheeling (Northbound)		
Comments:	Flight altitude - ~1000'. Followed cold front as it moved to SE. Crossed squall line NE of Wheeling. Noted O_3 depletion in Wheeling downwind plume.		

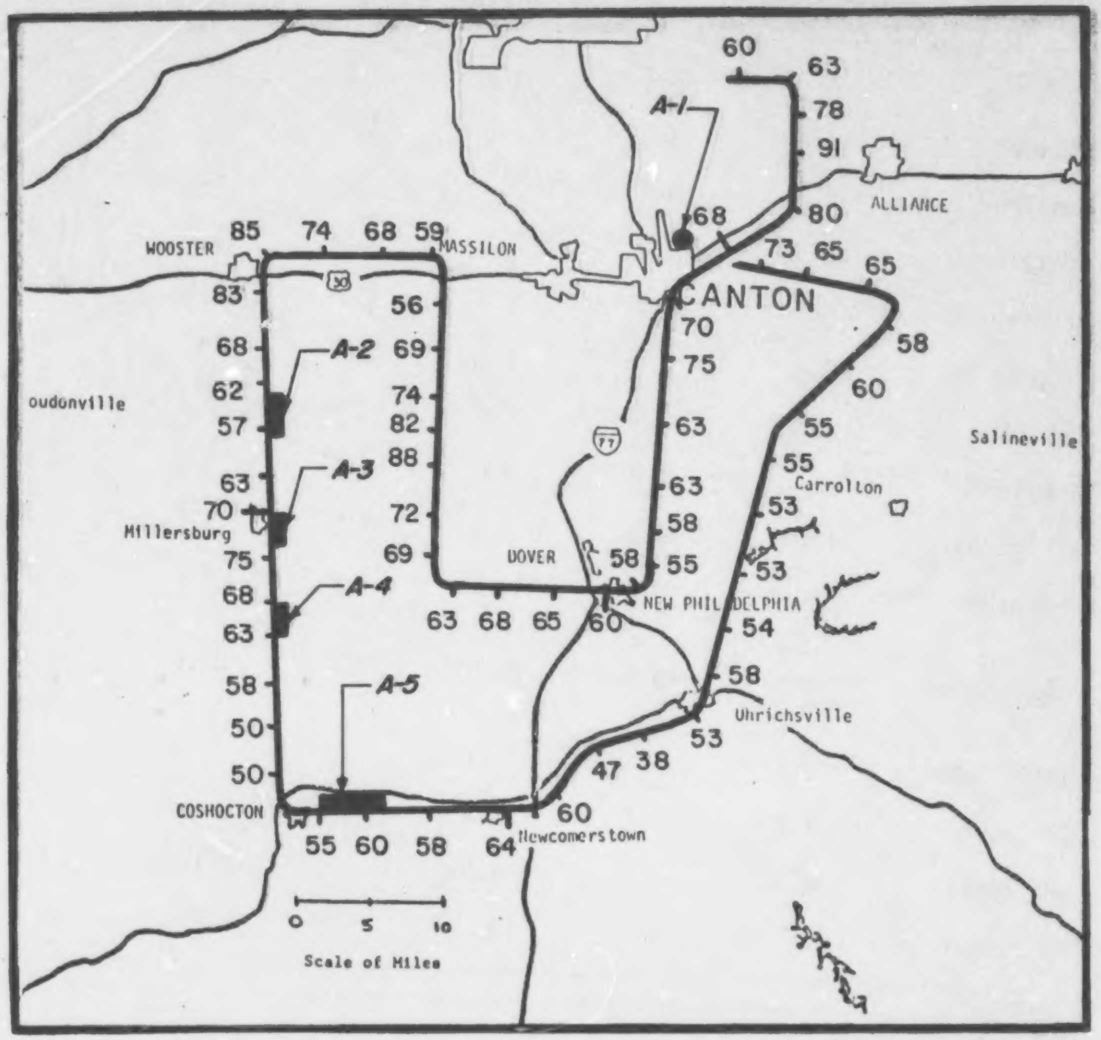
Figure B-17. Afternoon flight path on July 5, 1974.

TABLE B-5. AIRCRAFT COLLECTED BAG SAMPLES. JULY 5, 1974.

	A-1	A-2	A-3	A-4	A-5	A-6
Ethane	11.0	11.0	7.0	13.5	5.5	5.0
Ethylene	12.5	4.5	3.0	9.0	5.0	3.0
Acetylene	2.5	1.0	1.5	1.5	1.0	1.0
Propane	6.5	4.5	5.0	9.5	7.0	4.5
Propene	5.0	.5	1.0	2.5	*	*
i-Butane	4.0	2.5	1.5	7.0	2.5	1.0
n-Butane	9.0	7.0	3.0	14.0	5.0	2.5
i-Pentane	13.0	14.5	2.5	14.5	4.5	1.5
n-Pentane	4.5	3.0	1.5	4.5	2.0	.5
Total $\mu g/m^3$	68.0	48.5	26.0	76.0	32.5	19.0
NMTHC (ppm)	.3		.1		.2	.3
CO (ppm)	1.2		1.0		.8	1.2
CH_4 (ppm)	1.8		1.6		1.7	1.6
NO_x (ppb)	39		18		21	38

KEY (see map on previous page):

A-1	Over Malone College at 700'	(10:50 AM)
A-2	Over Malone College at 3000'	(11:50 AM)
A-3	20 miles upwind at 1000'	(11:40 AM)
A-4	14 miles downwind at 1000'	(11:20 AM)
A-5	32 miles downwind at 1000'	(11:10 AM)
A-6	75 miles S.E. of Canton at 1000'	(4:40 PM)



60
63
78
91
A-1
68
80
ALLIANCE
73
65
65
CANTON
70
75
63
63
58
55
58
60
55
55
Carrollton
53
53
54
58
Uhrichsville
53
47
38
60
Newcomerstown
WOOSTER
85
74
68
59
MASSILON
83
56
68
A-2
69
62
74
57
82
63
A-3
88
70
Millersburg
72
75
69
DOVER
58
68
A-4
63
68
65
60
NEW PHILADELPHIA
63
58
A-5
50
50
COSHOCTON
55
60
58
64
oudonville
Salineville
0
5
10
Scale of Miles

Time: 2:00 pm to 4:26 pm
Leg: 2:51 - 3:48 Long downwind
3:48 - 4:15 Short downwind
4:15 - 4:26 Upwind loop
Wind: 050° at 5 mph
Weather: Sunny and hot
Comments: Flight altitude - 1000'

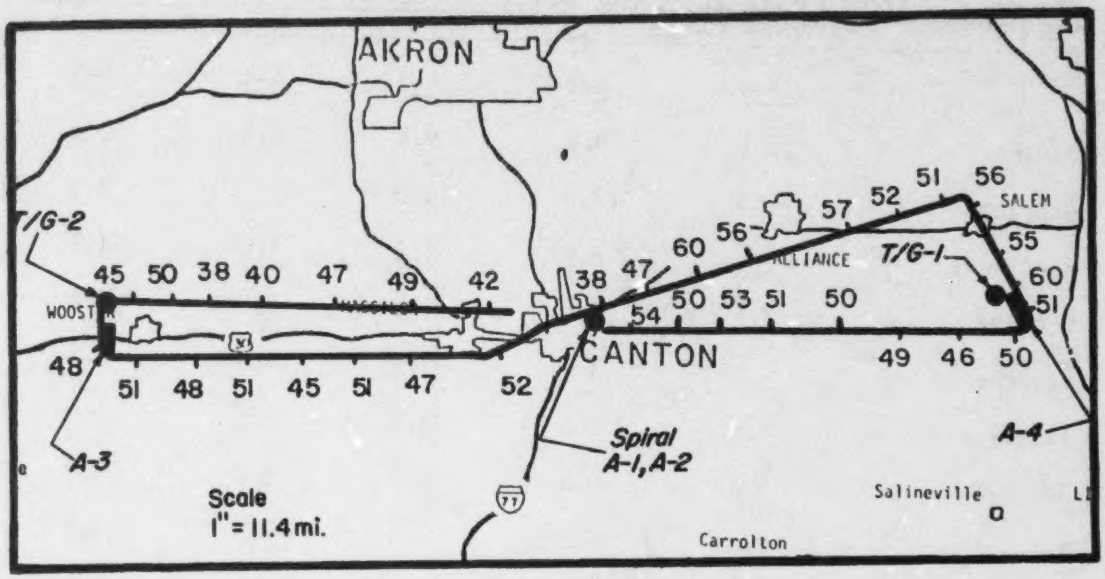
Figure B-18. Afternoon flight path on July 6, 1974.

TABLE B-6. AIRCRAFT COLLECTED BAG SAMPLES. JULY 6, 1974.

	A-1	A-2	A-3	A-4	A-5
Ethane	5.0	8.0	9.5	6.5	9.0
Ethylene	10.5	12.5	10.0		9.5
Acetylene	*	5.5	1.5	1.0	1.5
Propane	2.5	7.5	5.5	5.5	4.5
Propene	.5	3.0	3.5	2.0	1.5
i-Butane	.5	2.5	3.5	2.5	2.0
n-Butane	1.0	5.0	6.0	5.0	4.0
i-Pentane	1.0	6.0	6.5	6.0	4.5
n-Pentane	*	2.5	3.0	2.0	2.0
Total $\mu g/m^3$	21.0	52.5	49.0	30.5	38.5
NMTHC (ppm)	.2	.2	.4		.2
CO (ppm)	1.4	1.4	2.0		1.2
CH_4 (ppm)	1.5	1.7	1.7		1.7
NO_x (ppb)	11	13			15

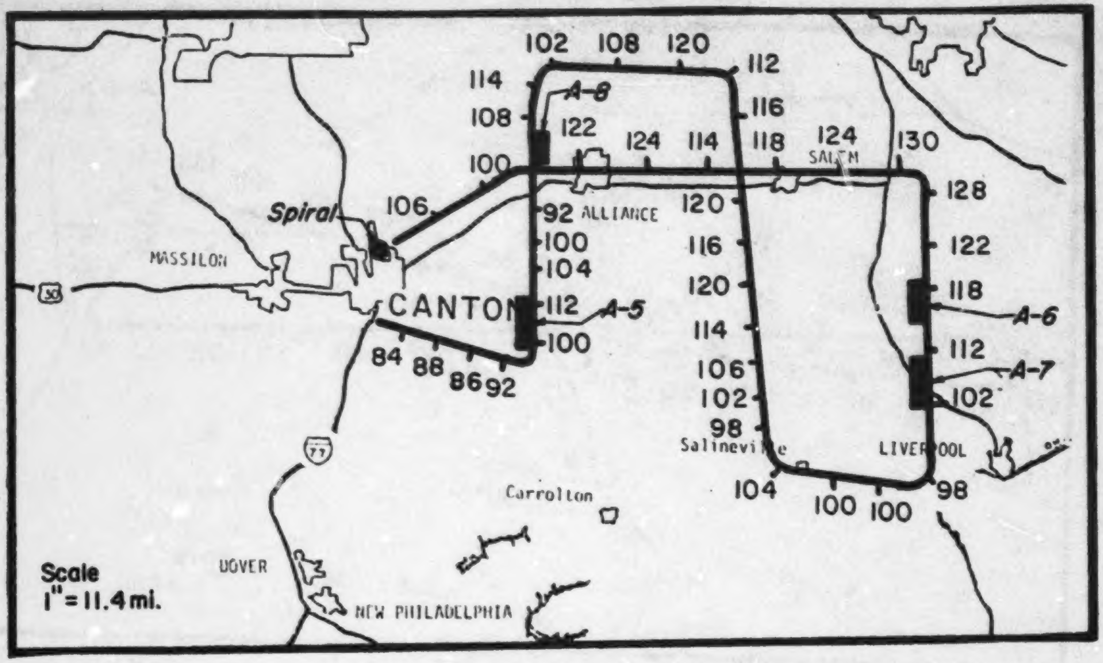
KEY (see map on previous page):

A-1	Over Malone College at 4000'	(2:30 PM)
A-2	30 miles downwind at 1000'	(3:40 PM)
A-3	32 miles downwind at 1000'	(3:35 PM)
A-4	36 miles downwind at 1000'	(3:30 PM)
A-5	444 miles downwind at 1000'	(3:20 PM)


AKRON
T/G-2
45 50 38 40 47 49 42
WOOST
48
51 48 51 45 51 47 52
A-3
38 47
60 56
57 52 51 56
SALEM
ALLIANCE
T/G-1
55 60 51
54 50 53 51 50
CANTON
49 46 50
A-4
Spiral
A-1, A-2
77
Scale
1" = 11.4 mi.
Salineville
Carrollton

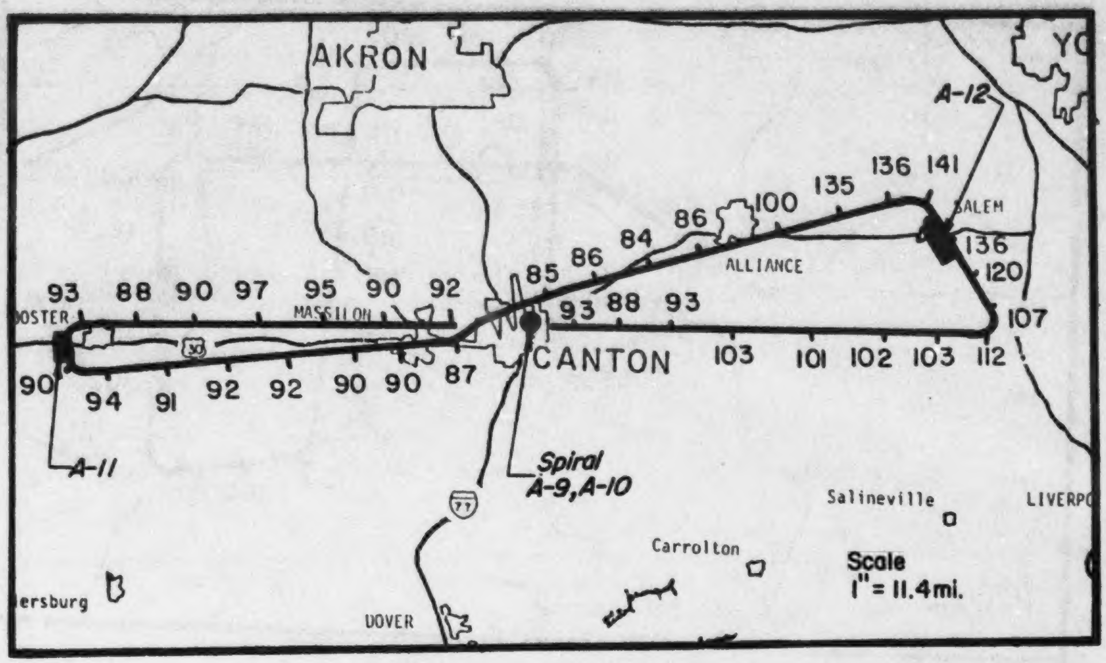
Time: 8:45 am to 10:41 am
Leg: 9:12 - 10:05 Downwind loop
10:05 - 10:41 Upwind loop
Wind: 250° at 4 mph
Weather: Warm, humid, and hazy
Comments: Flight altitude - 1000'

Figure B-19. Morning flight path on July 8, 1974.


102
108
120
112
114
A-8
108
122
116
124
114
118
124
130
100
SALEM
106
Spiral
92
ALLIANCE
120
128
100
104
116
122
MASSILON
30
120
118
CANTON
112
A-5
A-6
100
114
112
84
88
86
92
106
A-7
102
102
98
Salineville
LIVERPOOL
77
104
100
100
98
Carrollton
Scale
1" = 11.4 mi.
DOVER
NEW PHILADELPHIA

Time: 3:00 pm to 4:50 pm
Leg: 3:28 - 3:58 E and S to Liverpool
3:58 - 4:50 W-N-W-S-W
Wind: 290° at 6 mph
Weather: Hot and hazy
Comments: Flight altitude - 1000'

Figure B-20. Afternoon flight path on July 8, 1974.


AKRON
A-12
136
141
135
100
86
84
86
85
SALEM
136
120
107
ALLIANCE
93
88
90
97
95
90
92
OSTER
MASSILON
30
93
88
93
CANTON
103
101
102
103
112
90
94
91
92
92
90
90
87
A-11
Spiral
A-9, A-10
77
Salineville
LIVERP
Carrolton
Scale
1" = 11.4mi.
ersburg
DOVER

Time: 9:15 pm to 10:50 pm
Leg: 9:51 - 10:20 Downwind loop
10:20 - 10:50 Upwind loop
Wind: 260° at 3 mph.
Weather: Warm and humid
Comments: Flight altitude - 1000'

Figure B-21. Night flight path on July 8, 1974.

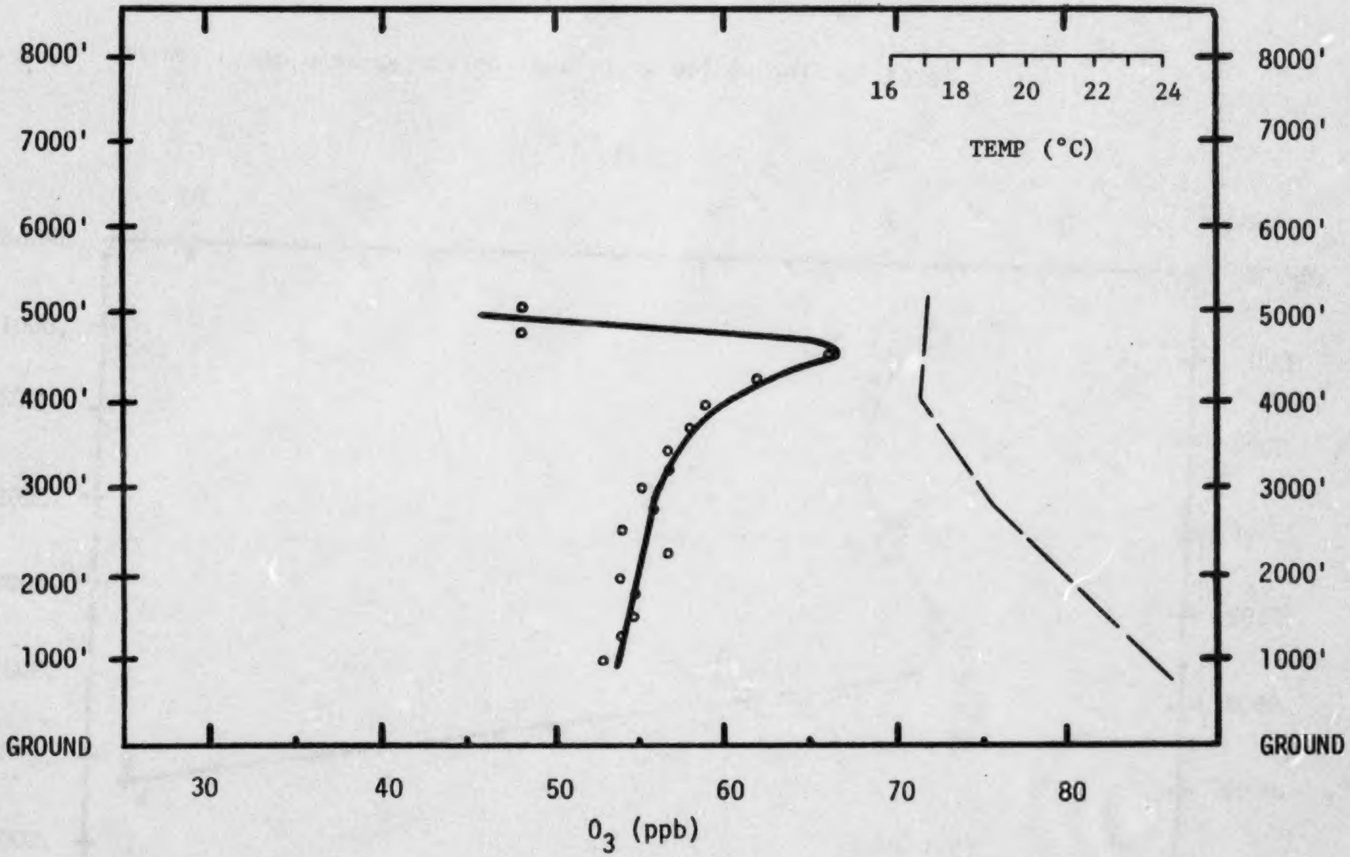


Figure B-22. Spiral climb over Malone College (9:11 am) on July 8, 1974.

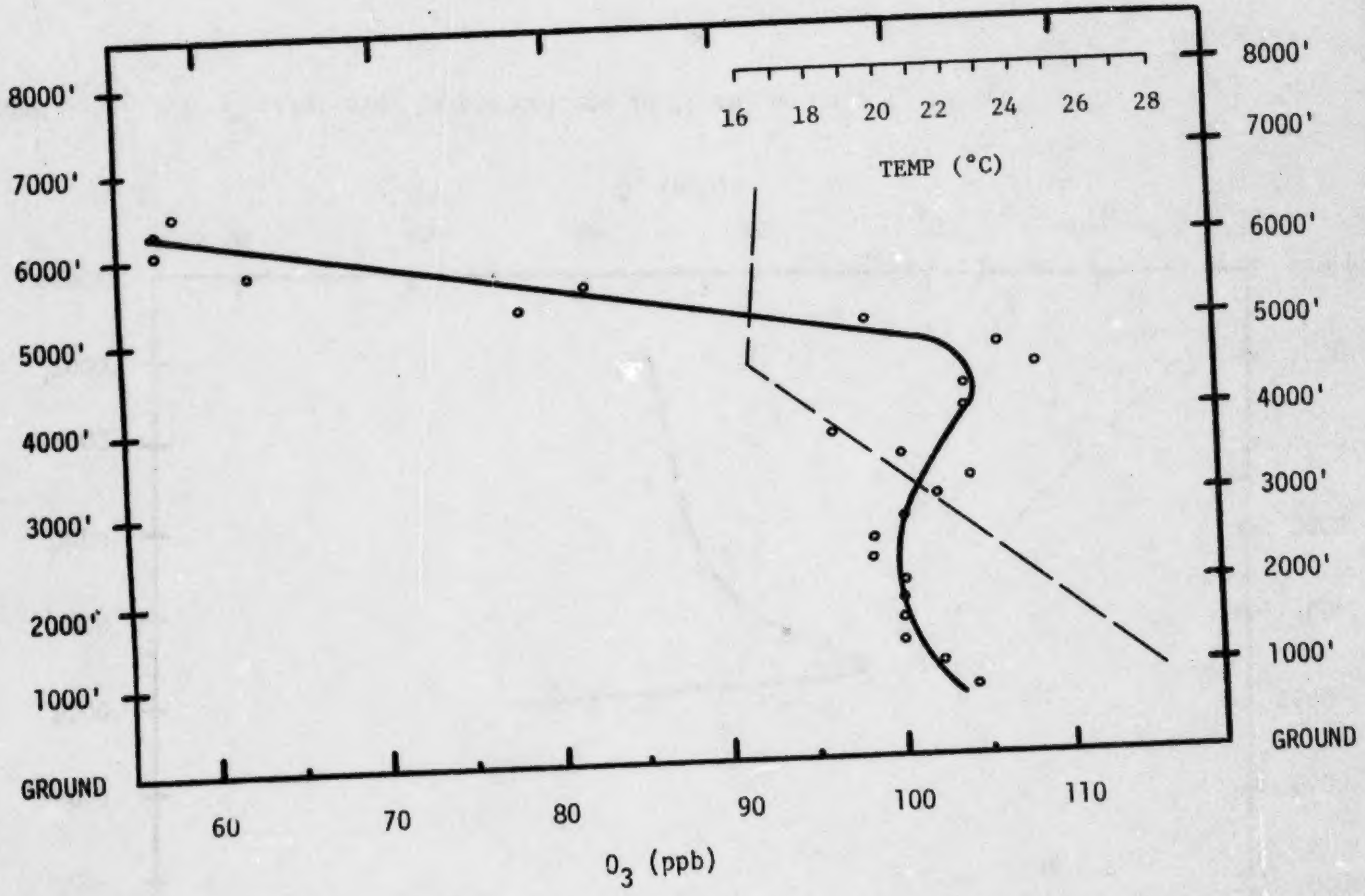


Figure B-23. Spiral climb over Malone College (3:28 pm) on July 8, 1974.

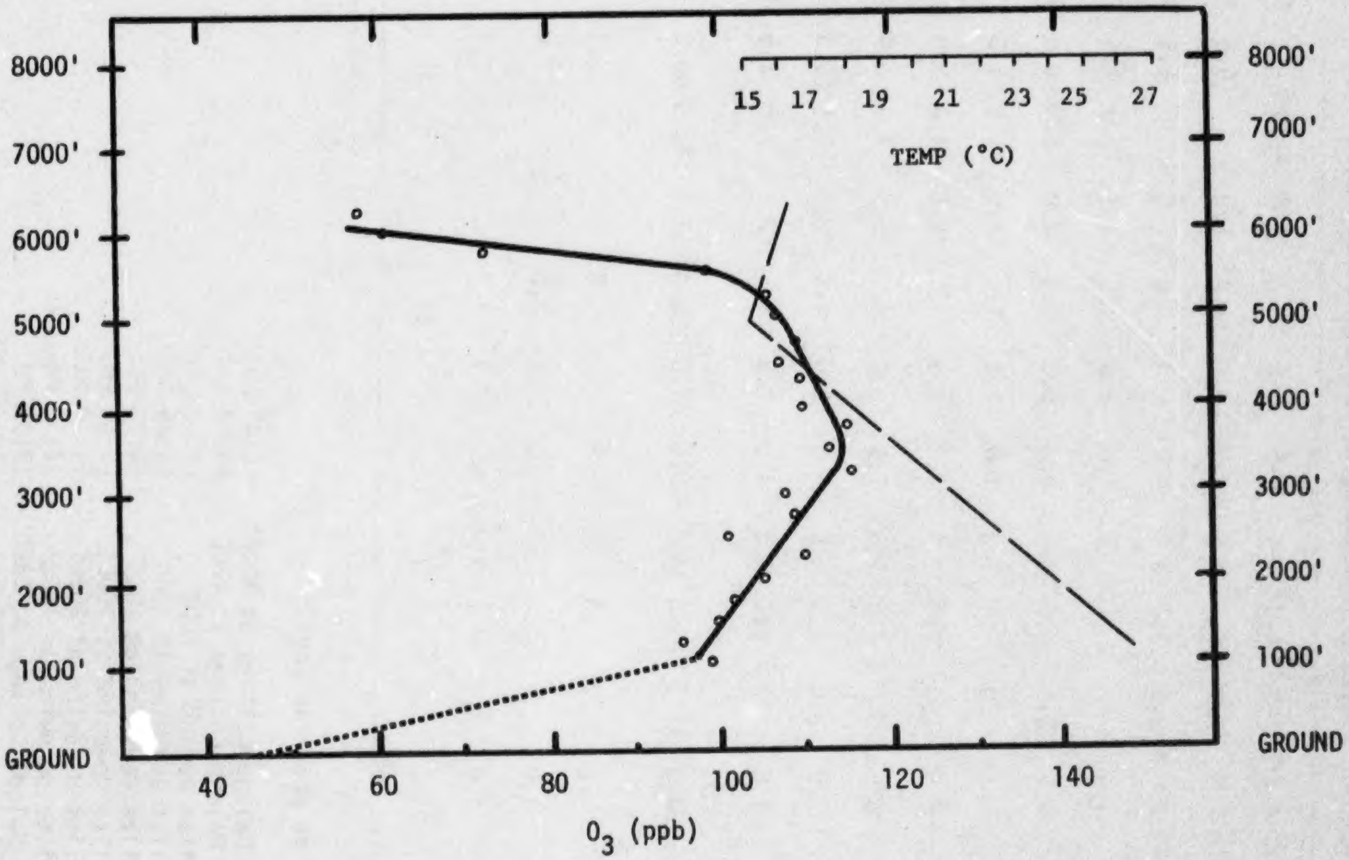


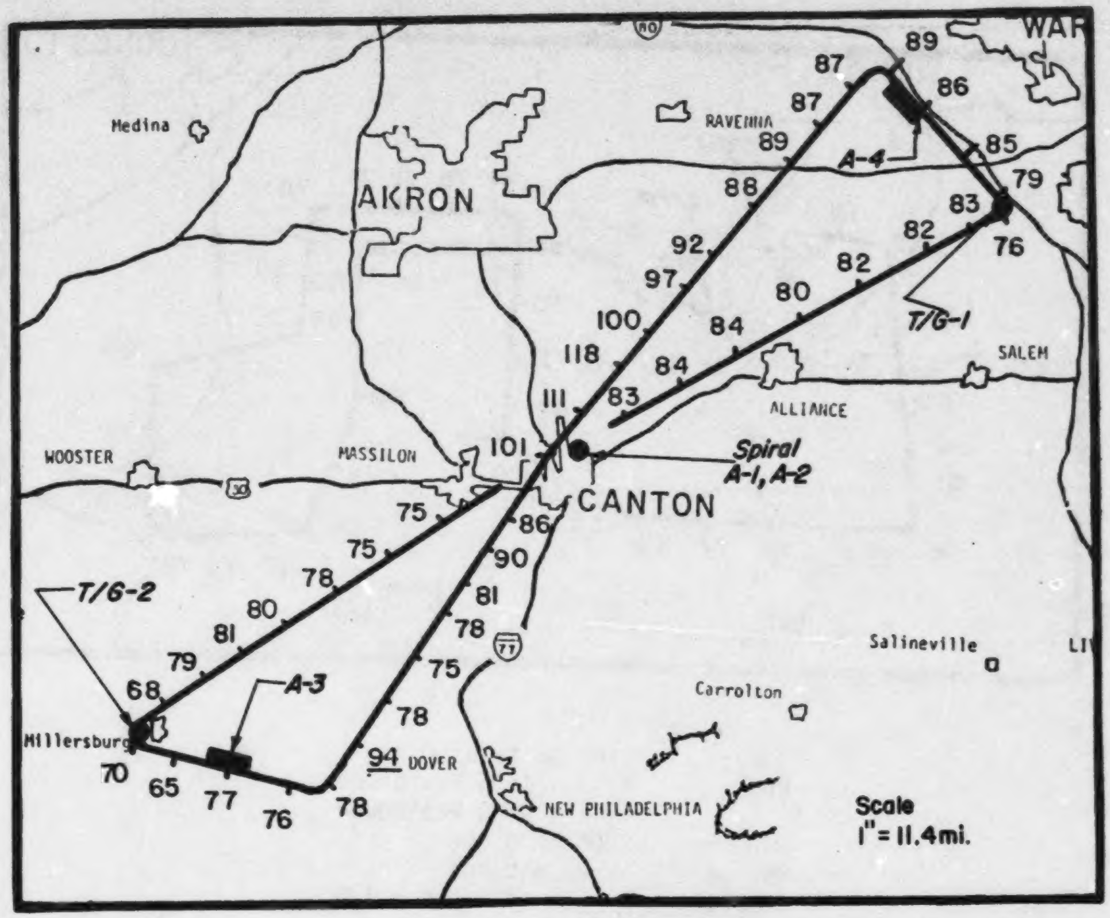
Figure B-24. Spiral climb over Malone College (9:52 pm) on July 8, 1974.

TABLE B-7. AIRCRAFT COLLECTED BAG SAMPLES. JULY 8, 1974.

	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-10	A-11	A-12
Ethane	7.5	7.0	9.5	9.5	14.5	10.5	4.0	5.0		9.5	21.5
Ethylene	2.0	3.5	3.5	3.5	4.0	6.0	3.0	8.5		5.5	21.0
Acetylene	1.0	*	.5	.5	1.0	2.0	1.5	1.5	2.0	1.5	5.0
Propane	4.5	3.0	4.0	5.5	9.0	6.0	5.0	4.0	6.5	6.0	15.0
Propene	*	1.0	.5	1.0	1.0	1.5	1.0	1.5	1.5	1.0	2.5
i-Butane	1.5	1.0	2.0	2.5	4.0	4.0	3.0	2.5	4.0	3.0	9.5
n-Butane	3.5	3.0	4.0	5.0	7.5	10.0	4.5	5.5	9.0	6.5	20.5
i-Pentane	3.0	2.0	4.5	6.0	5.5	5.0	4.5	10.5	12.5	10.5	28.0
n-Pentane	1.0	1.0	1.5	1.5	4.0	2.5	1.5	2.5	5.0	2.5	13.5
Total $\mu g/m^3$	24.0	21.5	30.0	35.0	50.5	47.5	28.0	41.5	40.5	46.0	136.5
NMTHC (ppm)	.2	.2	.3	.2	.3	.4	.2			.3	.8
CO (ppm)	1.0	.9	1.0	.9	1.0	1.6	1.0			.9	1.5
CH_4 (ppm)	1.6	1.6	1.7	1.7	1.7	1.7	1.7			1.7	2.0
NO_x (ppb)	21			21	19		18			31	

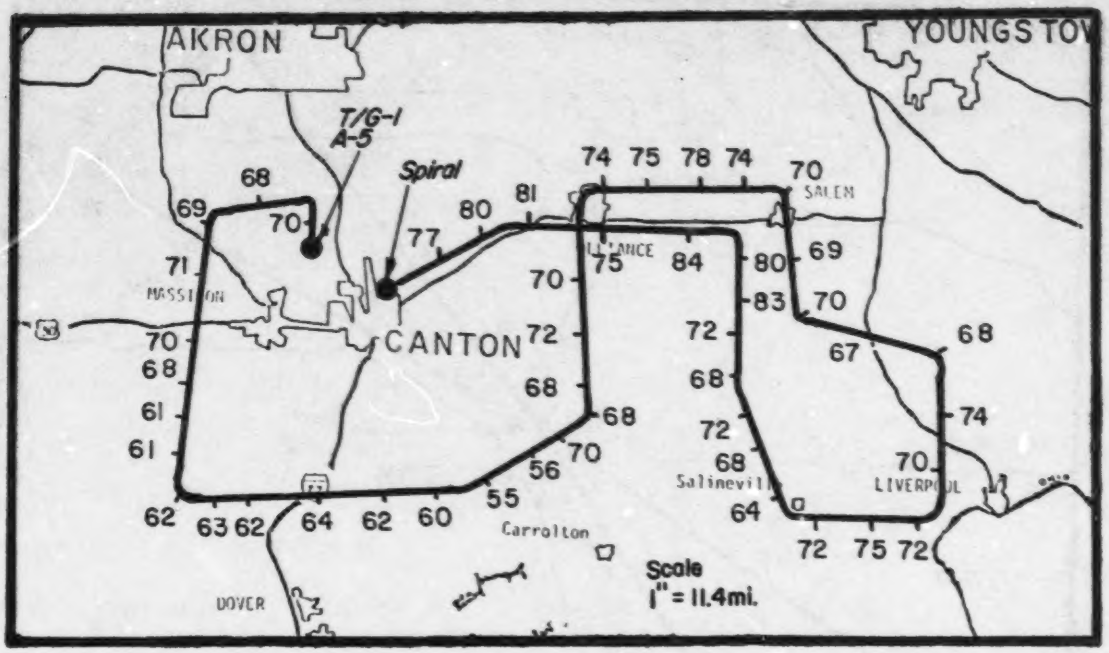
KEY (see map on previous page):

A-1	Over Malone College at 1000'	(8:45 AM)
A-2	Over Malone College at 4700'	(9:00 AM)
A-3	30 miles upwind at 1000'	(10:25 AM)
A-4	35 miles downwind at 1000'	(9:25 AM)
A-5	12 miles downwind at 1000'	(4:40 PM)
A-6	40 miles downwind at 1000'	(3:55 PM)
A-7	40 miles downwind at 1000'	(4:00 PM)
A-8	15 miles downwind at 1000'	(4:30 PM)
A-10	Over Malone College at 5800'	(9:35 PM)
A-11	30 miles upwind at 1000'	(10:40 PM)
A-12	35 miles downwind at 1000'	(10:05 PM)
A-9	Analysis Incomplete	


Medina
AKRON
RAVENNA
WAR
80
89
86
87
87
89
A-4
85
79
88
83
76
92
82
97
82
80
T/G-1
100
84
118
84
SALEM
83
111
ALLIANCE
WOOSTER
MASSILON
101
Spiral
A-1, A-2
30
CANTON
75
86
75
90
T/G-2
78
81
80
78
81
77
79
75
Salineville
A-3
68
78
Carrollton
Millersburg
94
DOVER
70
65
77
76
78
NEW PHILADELPHIA
Scale
1" = 11.4mi.

Time: 9:25 to 11:25 am
Leg: 10:02 - 10:50 Downwind loop
10:50 - 11:25 Upwind loop
Wind: 220° at 6 mph
Weather: Warm and hazy
Comments: Flight altitude - 1000'

Figure B-25. Morning flight path on July 9, 1974.


AKRON
YOUNGSTOV
T/G-I
A-5
Spiral
74
75
78
74
70
SALEM
68
69
70
80
81
77
71
MASSILLON
75
84
80
69
70
83
70
70
72
CANTON
72
68
67
68
68
68
61
61
68
72
74
70
68
56
70
62
63
62
64
62
60
55
Salineville
LIVERPOOL
64
72
75
72
Carrolton
Scale
1" = 11.4mi.
DOVER

Time: 4:00 pm to 5:50 pm
Leg: 4:18 - 4:45 Eastbound
4:45 - 5:50 Westbound
Wind: 280° at 8 mph
Weather: Sunny and hot
Comments: Flight altitude - 1000'

Figure B-26. Afternoon flight path on July 9, 1974.

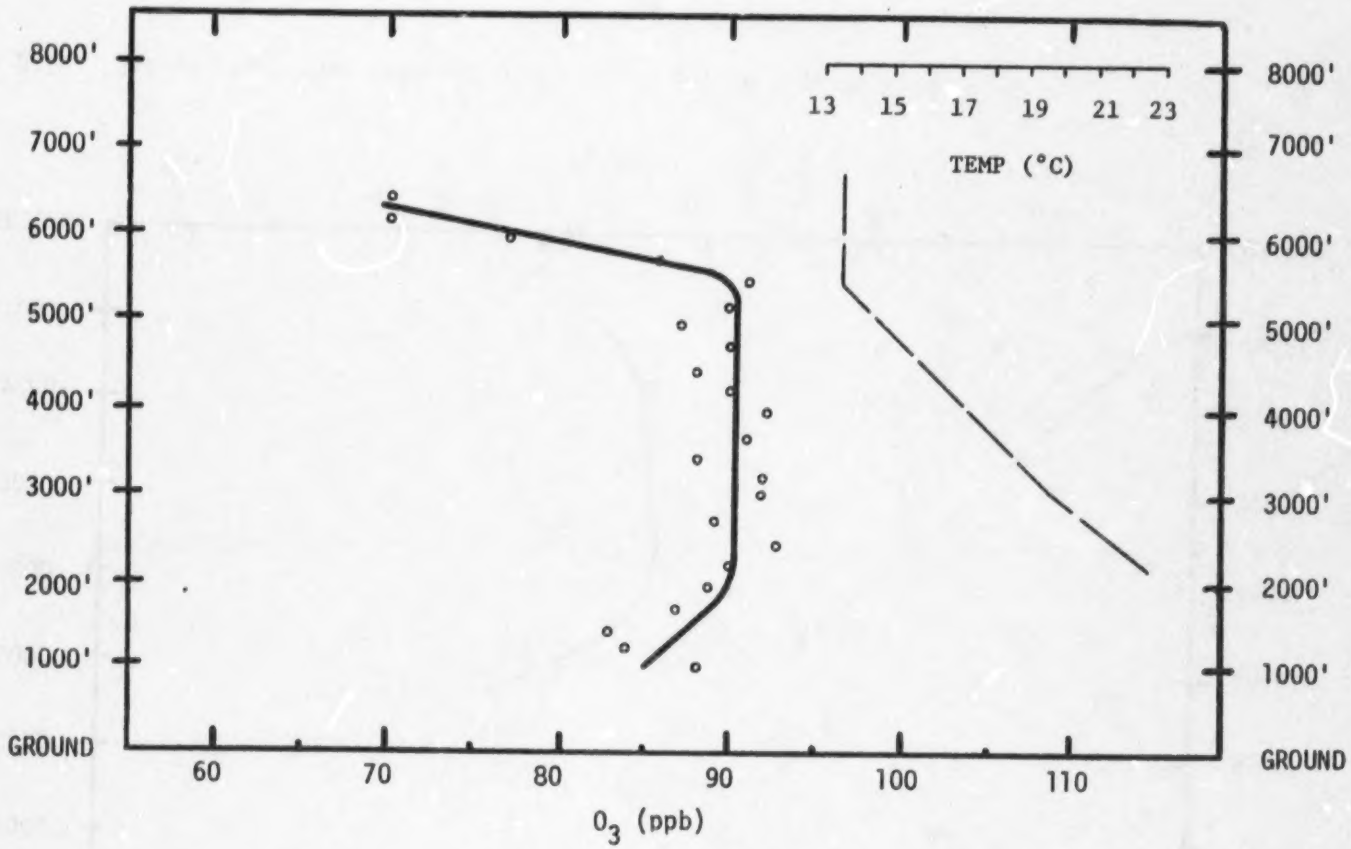


Figure B-27. Spiral climb over Malone College (10:02 am) on July 9, 1974.

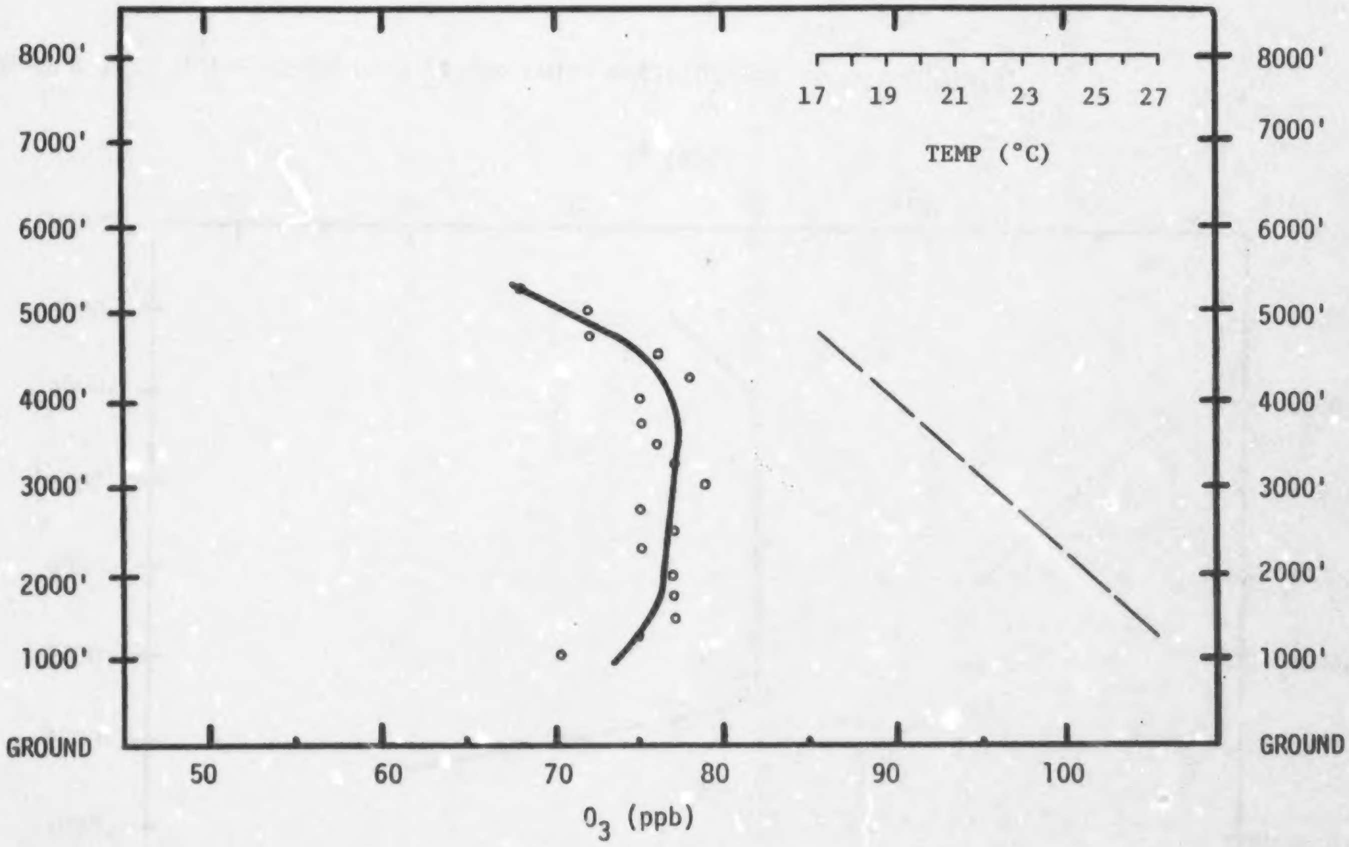


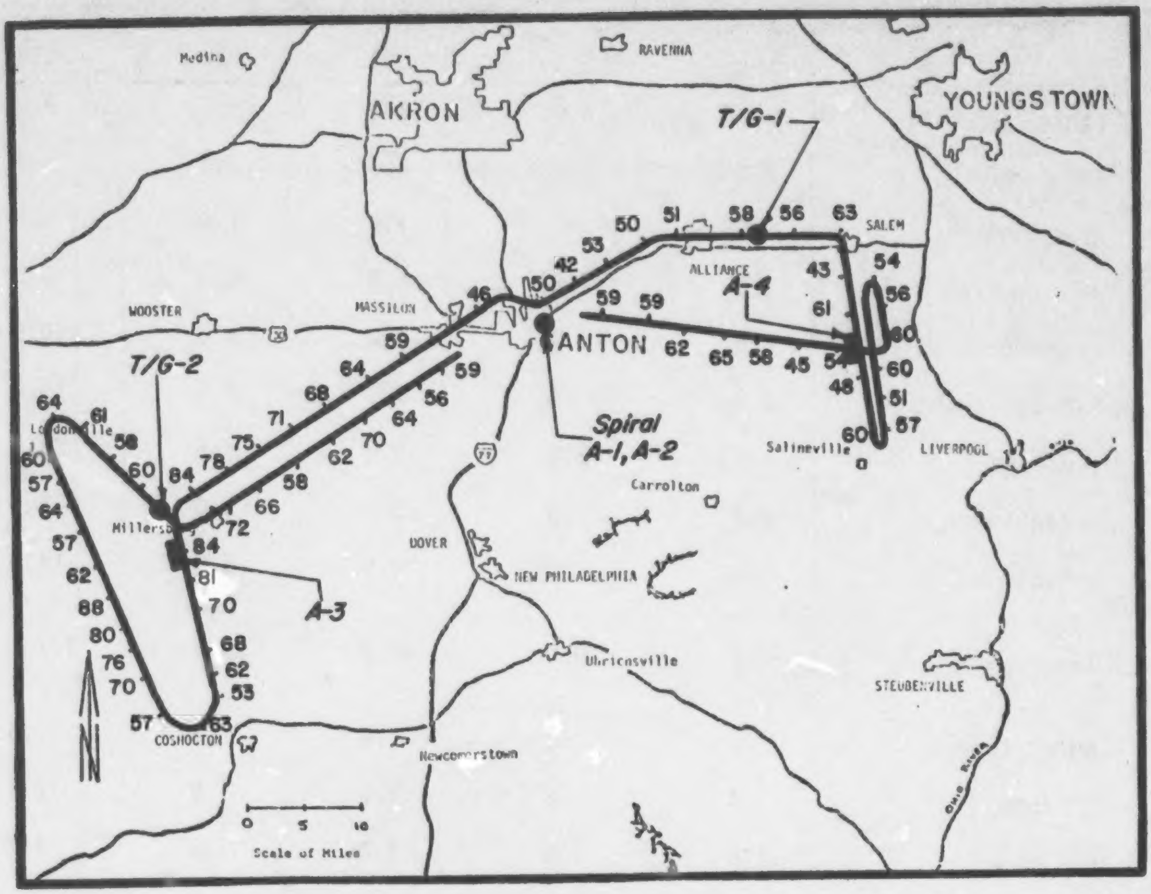
Figure B-28. Spiral climb over Malone College (4:16 pm) on July 9, 1974.

TABLE B-8. AIRCRAFT COLLECTED BAG SAMPLES. JULY 9, 1974.

	A-1	A-2	A-3	A-4	A-5
Ethane	6.0	6.0	12.5	9.5	9.0
Ethylene	5.0	3.5	3.5	3.5	5.5
Acetylene	.5	*	1.5	2.0	3.5
Propane	3.0	2.5	8.0	6.5	16.5
Propene	.5	1.0	1.0	1.0	10.5
i-Butane	2.0	2.0	2.5	2.5	19.0
n-Butane	3.0	2.0	5.0	5.5	23.5
i-Pentane	3.0	2.0	3.5	5.0	28.0
n-Pentane	1.0	1.0	2.5	3.0	11.0
Total $\mu g/m^3$	24.0	20.0	40.0	38.5	127
NMTHC (ppm)	.2	.3	.4	.3	.5
CO (ppm)	.8	.8	1.1	.9	2.1
CH_4 (ppm)	1.6	1.6	1.7	1.6	1.7
NO_x (ppb)	18			24	

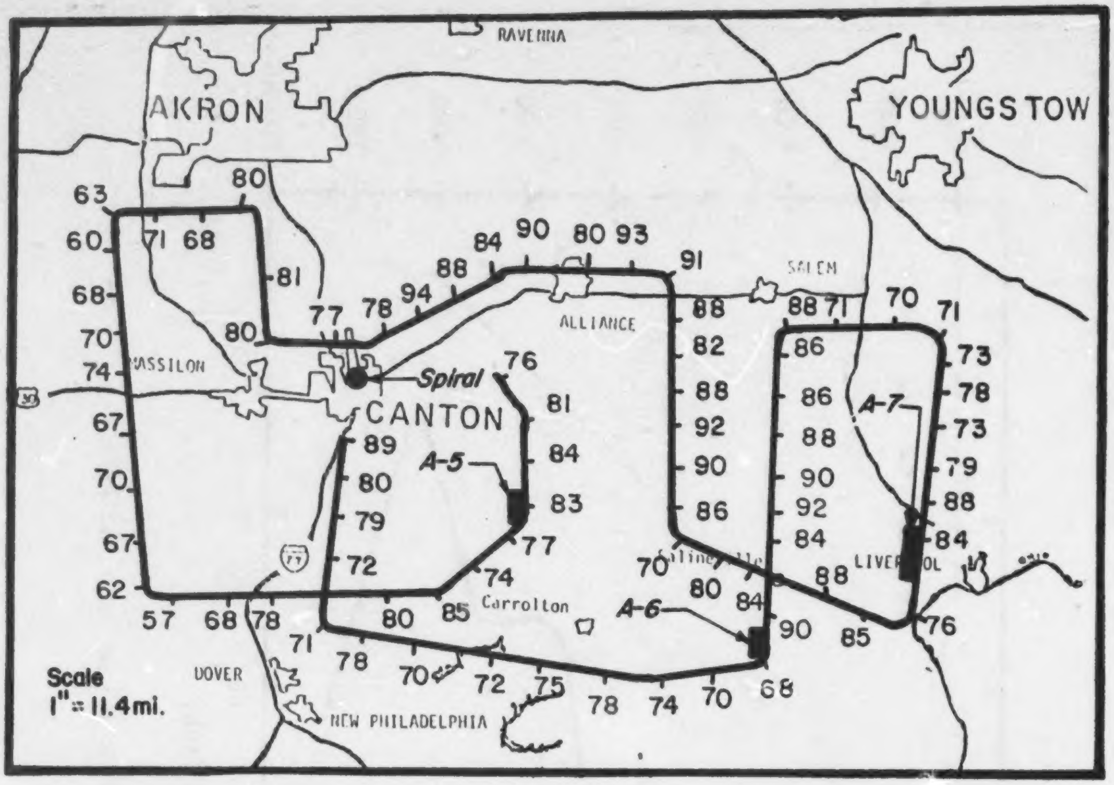
KEY (see map on previous page):

A-1	Over Malone College at 1000'	(9:30 AM)
A-2	Over Malone College at 6400'	(9:45 AM)
A-3	30 miles upwind at 1000'	(11:20 AM)
A-4	35 miles downwind at 1000'	(10:30 AM)
A-5	Touch and go at Akron-Canton airport	(5:45 PM)


Medina
RAVENNA
AKRON
YOUNGSTOWN
T/G-1
SALEM
ALLIANCE
A-4
WOOSTER
MASSILLON
CANTON
T/G-2
Spiral
A-1, A-2
Loudonville
Millersburg
A-3
DOVER
NEW PHILADELPHIA
Carrolton
Salineville
LIVERPOOL
Uhricnsville
STEUBENVILLE
Newcomerstown
COSHOCTON
Ohio River
N
0 5 10
Scale of Miles

Time: 8:25 am to 11:15 am
Leg: 8:58 - 9:56 Downwind loop
9:56 - 11:15 Upwind loop
Wind: 250° at 6 mph
Weather: Cool and sunny
Comments: Flight altitude - 1000'

Figure B-29. Morning flight path on July 10, 1974.


RAVENNA
AKRON
YOUNGSTOW
SALEM
ALLIANCE
ASSILON
CANTON
Spiral
A-5
A-6
A-7
Carrolton
LIVER OL
DOVER
NEW PHILADELPHIA
Scale
1" = 11.4mi.
63
60
68
70
74
67
70
67
62
57
68
78
71
68
80
81
80
77
78
94
88
84
90
80
93
91
88
82
88
92
90
86
70
80
84
90
68
76
81
84
83
77
74
85
80
89
80
79
72
71
78
70
72
75
78
74
70
88
71
70
71
86
86
88
90
92
84
88
85
76
73
78
73
79
88
84

Time: 2:10 pm to 4:25 pm
Leg: 2:15 - 3:35 Long downwind
3:35 - 4:05 Upwind loop
4:05 - 4:25 Short downwind
Wind: 320° at 8 mph
Weather: Hot, cloudy, and humid
Comments: Flight altitude - 1000'

Figure B-30. Afternoon flight path on July 10, 1974.

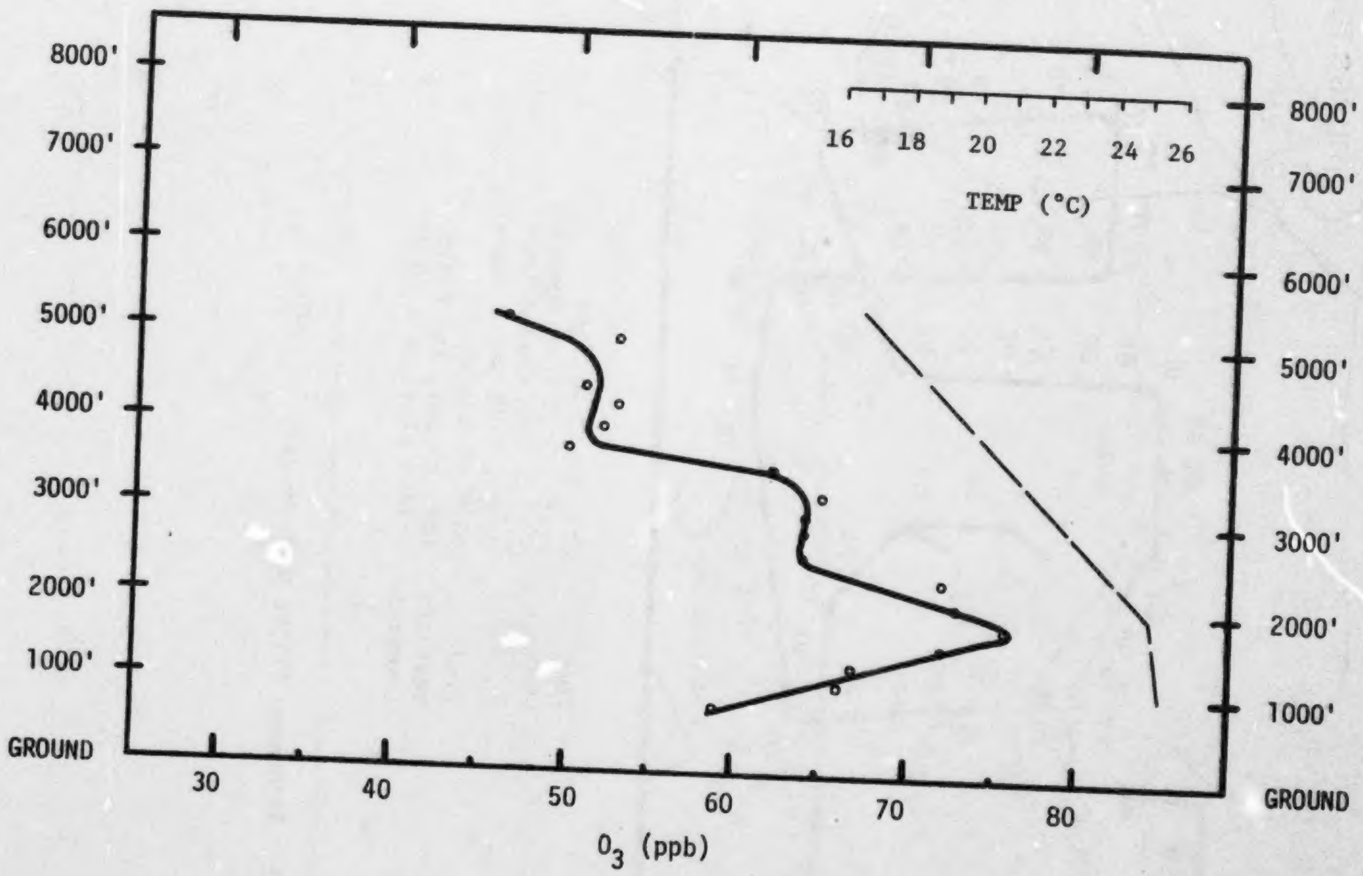


Figure B-31. Spiral climb over Malone College (8:58 am) on July 10, 1974.

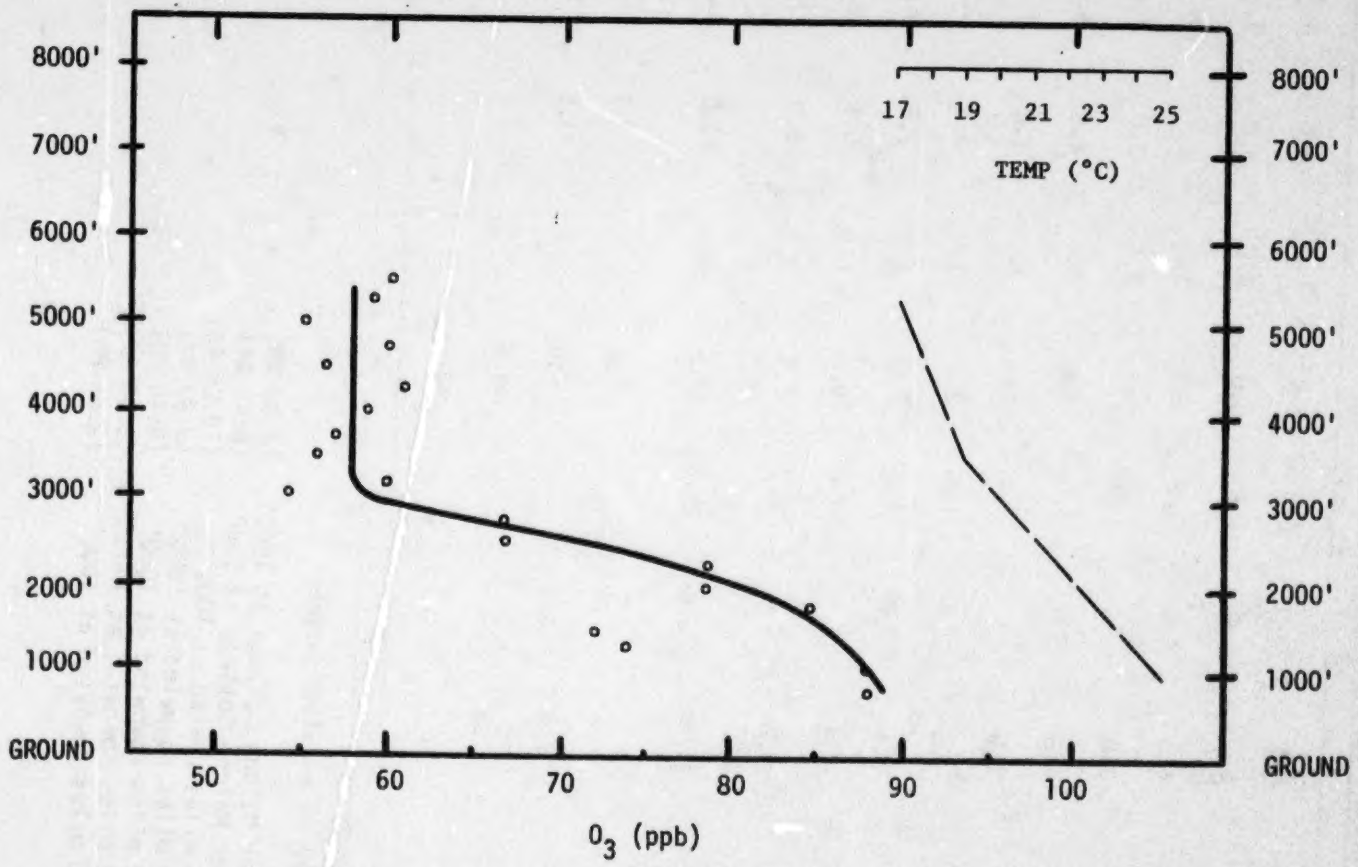


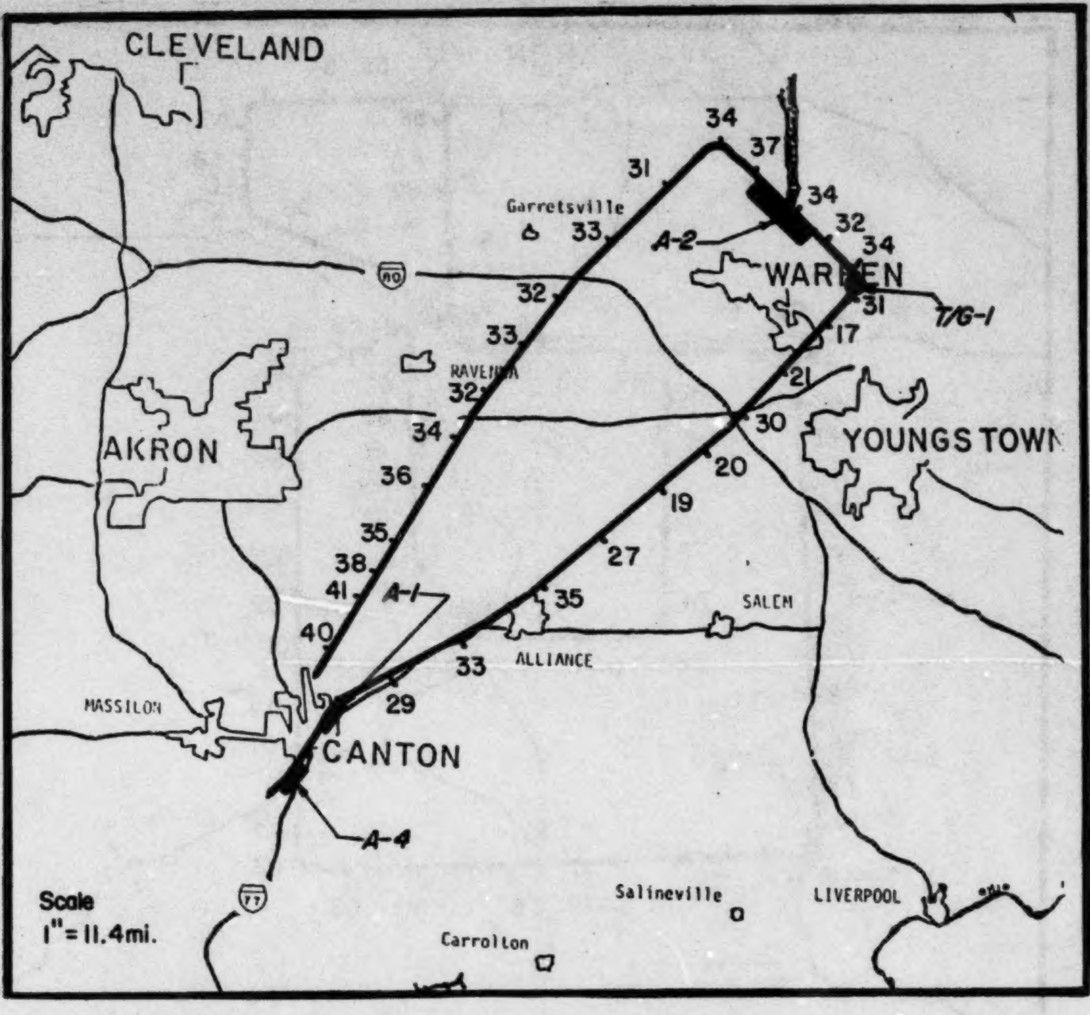
Figure B-32. Spiral climb over Malone College (2:11 pm) on July 10, 1974.

TABLE B-9. AIRCRAFT COLLECTED BAG SAMPLES. JULY 10, 1974.

	A-1	A-2	A-3	A-4	A-5	A-6	A-7
Ethane	8.0	6.5	6.5	6.0	8.5	9.0	9.0
Ethylene	4.0	2.0	3.0	4.0	5.5	4.5	5.5
Acetylene	2.0	*	.6	*	1.5	2.0	2.5
Propane	6.5	3.0	4.0	4.5	4.5	6.5	8.0
Propene	1.5	*	1.0	1.0	1.0	1.5	1.5
i-Butane	3.0	2.0	1.5	3.5	3.0	3.5	3.0
n-Butane	6.5	3.0	4.0	7.0	7.0	7.5	6.5
i-Pentane	6.5	2.5	7.0	10.0	6.0	5.5	5.5
n-Pentane	3.0	1.0	2.0	2.5	2.5	3.0	3.0
Total $\mu g/m^3$	41.0	20.0	29.5	38.5	39.5	43.0	44.5
NMTHC (ppm)	.4	.4		.4		.4	.4
CO (ppm)	1.0	1.1		.9		1.5	1.4
CH_4 (ppm)	1.6	1.6		1.6		1.7	1.7
NO_x (ppb)	23			17			

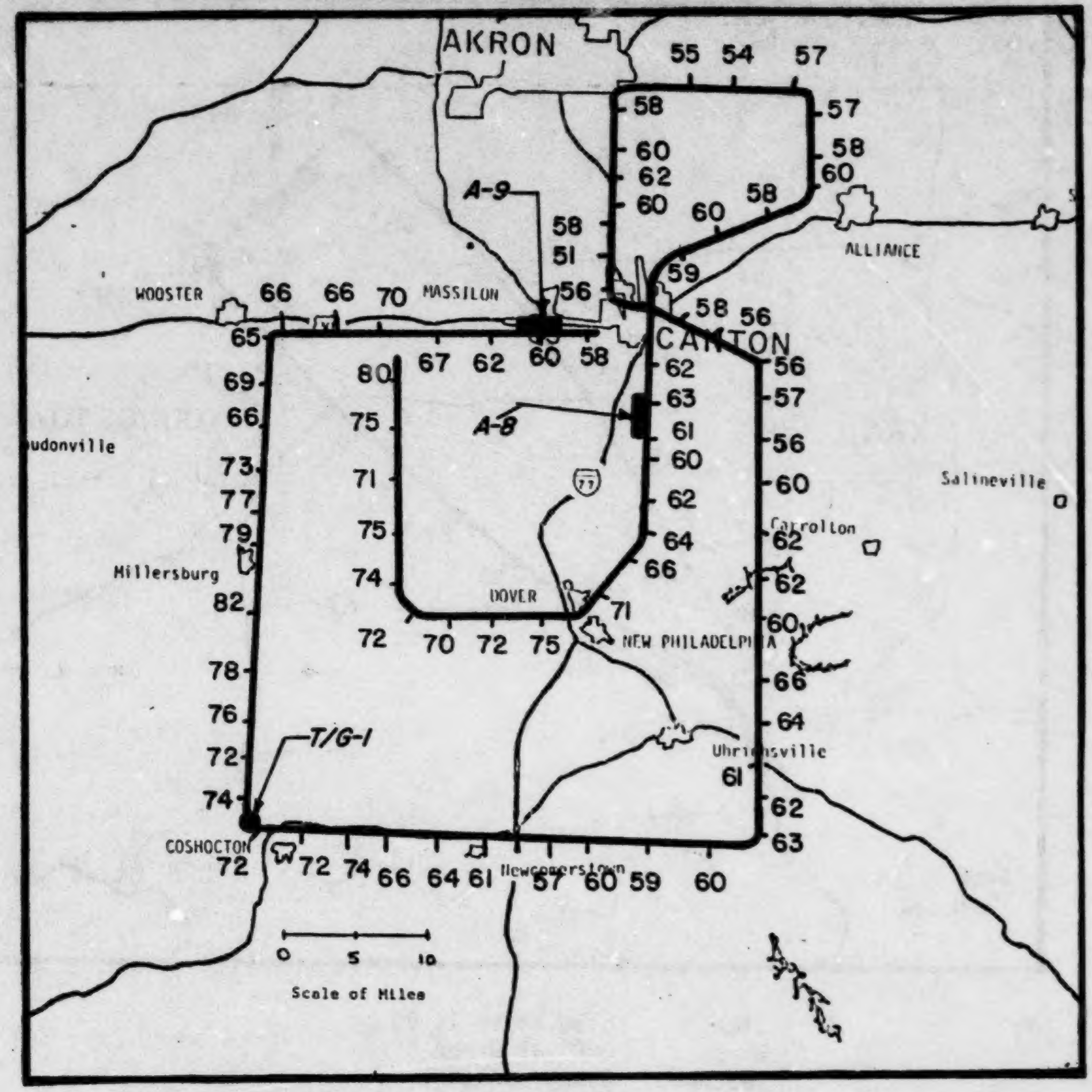
KEY (see map on previous page):

A-1	Over Malone College at 1000'	(8:30 AM)
A-2	Over Malone College at 5000'	(8:45 AM)
A-3	25 miles upwind at 1000'	(10:20 AM)
A-4	30 miles downwind at 1000'	(9:30 AM)
A-5	12 miles downwind at 1000'	(4:10 PM)
A-6	32 miles downwind at 1000'	(2:35 PM)
A-7	40 miles downwind at 1000'	(2:55 PM)


CLEVELAND
Garretsville
WARREN
T/G-1
A-2
RAVENNA
AKRON
YOUNGSTOWN
SALEM
ALLIANCE
A-1
MASSILON
CANTON
A-4
Salineville
LIVERPOOL
Carrolton
80
77
Scale
1" = 11.4mi.
34
37
31
34
33
32
34
32
31
17
33
21
32
30
34
20
36
19
35
27
38
41
35
40
33
29

Time: 8:50 am to 11:00 am
Wind: 040° at 9 mph
Weather: Sunny and cool
Comments: Flight altitude - 1000'
counter-clockwise route

Figure B-33. Morning flight path on July 11, 1974.


AKRON
ALLIANCE
WOOSTER
MASSILON
CANTON
A-9
A-8
Loudonville
Millersburg
Salineville
Carrollton
DOVER
NEW PHILADELPHIA
Uhrichsville
T/G-1
COSHOCTON
Newcomerstown
55 54 57
58 60 62 60 58 51 56
57 58 60 58 60 59 58 56
66 66 70 60 58
65 69 66 73 77 79 82 78 76 72 74
80 67 62 75 71 75 74 72 70 72 75
62 63 61 60 62 64 66 71
56 57 56 60 62 62 60 66 64 61 62 63
72 72 74 66 64 61 57 60 59 60
0 5 10
Scale of Miles

Time: 2:45 pm to 4:50 pm
Leg: 3:00 - 4:08 Long downwind
4:08 - 4:38 Upwind loop
4:38 - 4:50 Short downwind

Wind: 040° at 15 mph
Weather: Sunny and warm
Comments: Flight altitude - 1000'

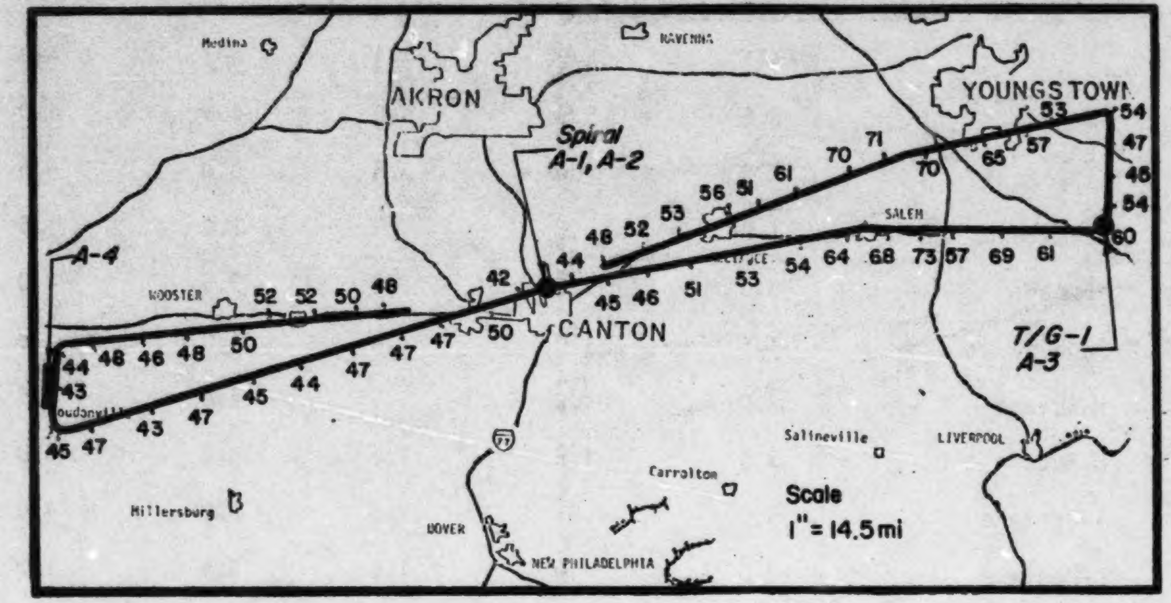
Figure B-34. Afternoon flight path on July 11, 1974.

TABLE B-10. AIRCRAFT COLLECTED BAG SAMPLES. JULY 11, 1974.

	A-1	A-2	A-4	A-8	A-9
Ethane	6.5	5.5	4.0	4.5	6.0
Ethylene	8.5	4.0	3.5	3.0	6.5
Acetylene	1.0	.5	*	1.0	.5
Propane	3.5	3.0	2.0	3.5	4.0
Propene	1.5	1.0	1.0	1.0	1.5
i-Butane	2.0	1.0	1.5	4.0	1.5
n-Butane	3.5	1.5	1.5	8.0	3.0
i-Pentane	5.5	4.0	2.5	8.0	4.0
n-Pentane	2.0	1.0	1.0	4.5	1.0
Total $\mu g/m^3$	34.0	21.5	17.0	37.5	28.0
NMTHC (ppm)		.2		.4	.2
CO (ppm)		.7		1.1	1.5
CH_4 (ppm)		1.6		1.6	1.7
NO_x (ppb)		6		16	11

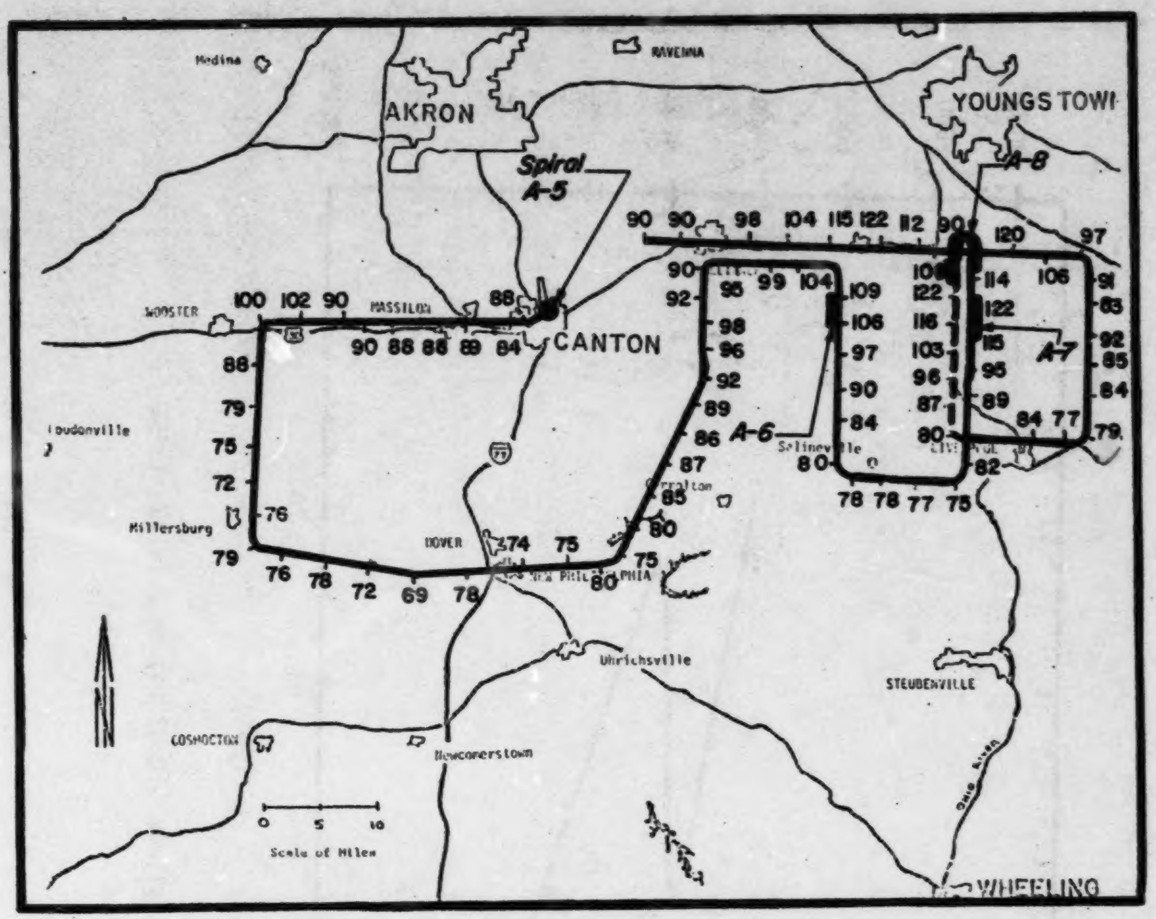
KEY (see map on previous page):

A-1	Over Malone College at 1000'	(9:00 AM)
A-2	50 miles upwind at 1000'	(10:30 AM)
A-4	Over S.W. Canton at 3200'	(9:25 AM)
A-8	10 miles downwind at 1000'	(2:30 PM)
A-9	5 miles S.E. of Canton at 1000'	(3:00 PM)
A-3,5,6,7	Refinery Samples	


Medina
RAVENNA
AKRON
YOUNGSTOWN
Spiral A-1, A-2
A-4
WOOSTER
CANTON
SALEM
T/G-1 A-3
Loudonville
Millersburg
DOVER
NEW PHILADELPHIA
Carrolton
Salineville
LIVERPOOL
77
Scale 1" = 14.5 mi
52 52 50 48
44 48 46 48 50
43
45 47 43 47 45 44 47 47 47 50 42
44 48 52 53 56 51 61 70 71 70 65 57 53
54 47 46 54 60
45 46 51 53 54 64 68 73 57 69 61

Time: 9:00 am to 11:25 am
Leg: 9:05 - 10:11 Upwind loop
10:32 - 11:25 Downwind loop
Wind: 070° at 7 mph
Weather: Sunny and cool
Comments: Flight altitude - 1000'

Figure B-35. Morning flight path on July 12, 1974.


Medina
RAVENNA
AKRON
YOUNGS TOWN
Spiral A-5
A-8
A-7
A-6
WOOSTER
MASSILON
CANTON
Loudonville
Millersburg
DOVER
NEW PHILADELPHIA
Carrollton
Salineville
STEUBENVILLE
Uhrichsville
COSHOCTON
Newcomerstown
Ohio River
WHEELING
0 5 10
Scale of Miles

Time: 2:00 pm to 4:30 pm
Leg: 2:23 - 3:19 West leg
~3:50 Dotted leg
Wind: Variable at 3 mph
Weather: Warm with high clouds
Comments: Dotted line is path at 2000'
Solid line is at 1000'

Figure B-36. Afternoon flight path on July 12, 1974

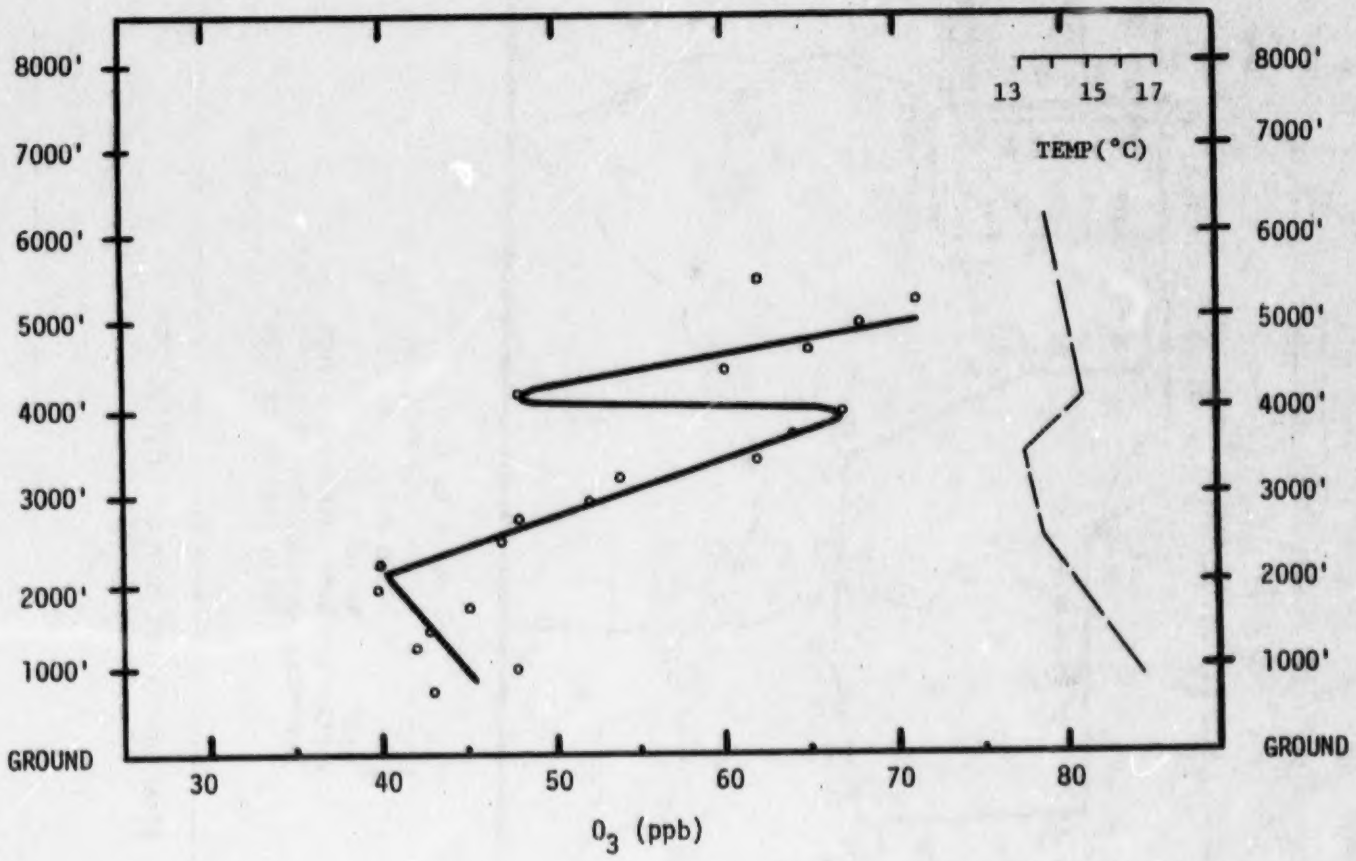


Figure B-37. Spiral climb over Malone College (10:32 am) on July 12, 1974.

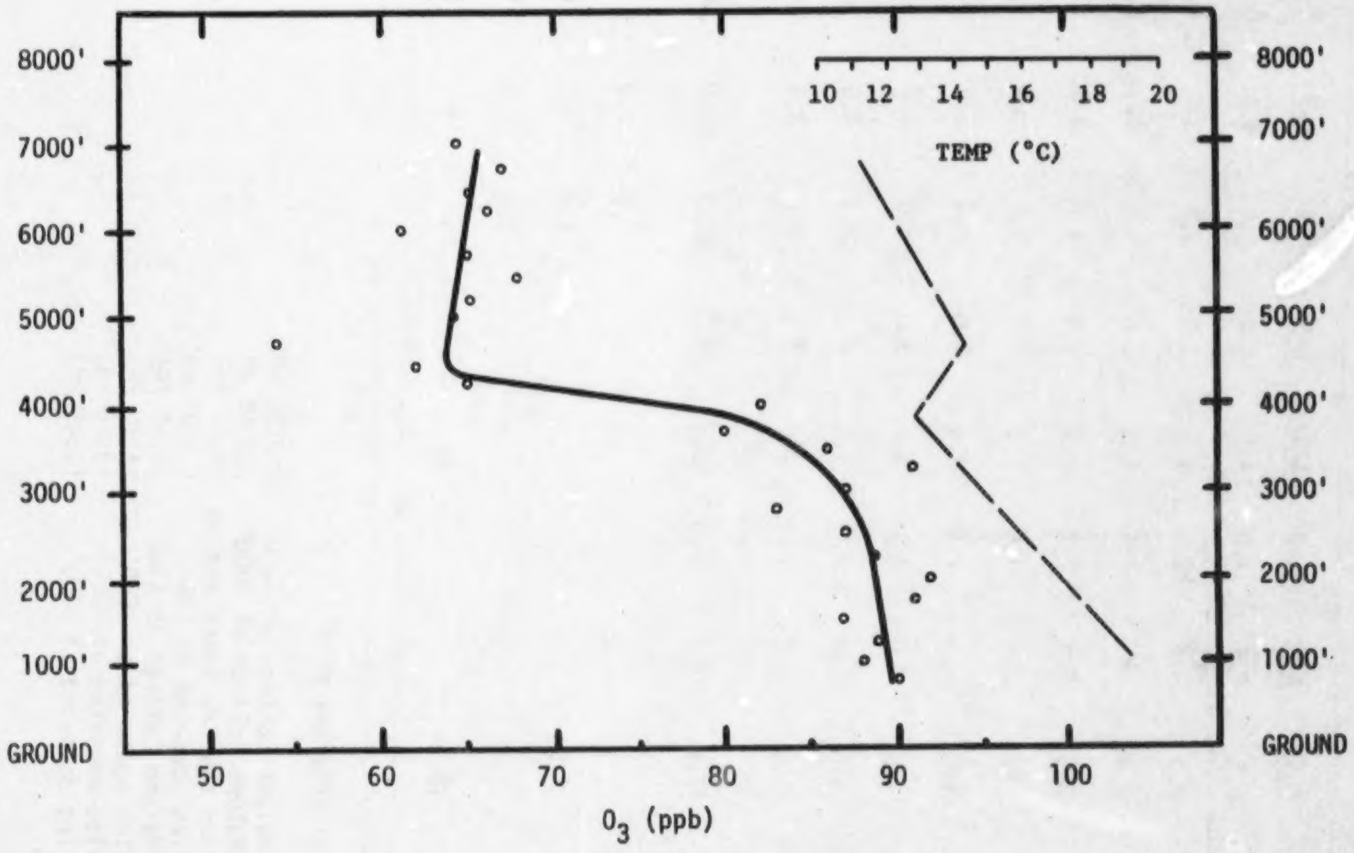


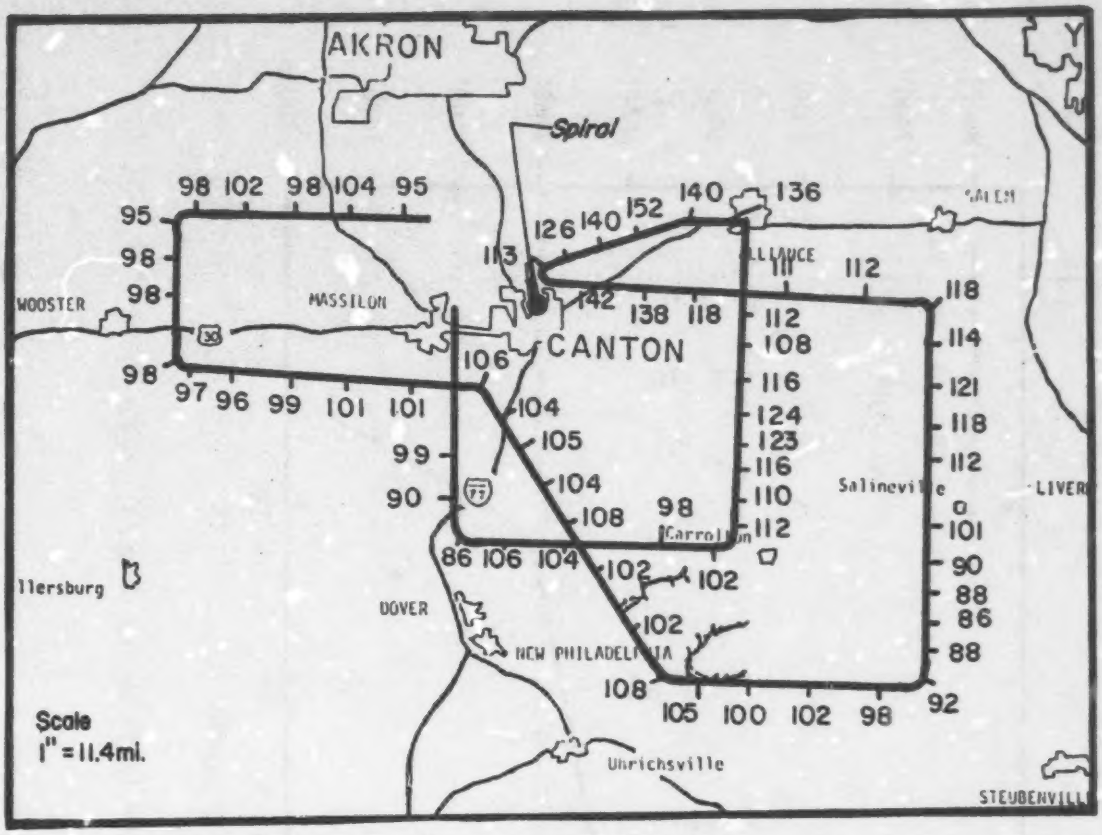
Figure B-38. Spiral climb over Malone College (2:21 pm) on July 12, 1974.

TABLE B-11. AIRCRAFT COLLECTED BAG SAMPLES. JULY 12, 1974.

	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8
Ethane	6.5	5.5	7.0	15.5	4.0	8.0	4.5	6.5
Ethylene	2.5	3.5	13.5	4.0	3.5	3.5	3.0	4.0
Acetylene	1.0	*	1.5	1.0	1.0	1.5	2.0	2.0
Propane	3.5	2.5	3.5	8.5	2.5	4.0	3.0	3.5
Propene	*	.5	1.5	1.5	1.5	1.5	.5	.5
i-Butane	1.5	.5	2.0	2.5	2.0	2.0	3.0	3.0
n-Butane	4.0	1.0	4.0	5.0	3.0	5.0	4.0	5.5
i-Pentane	3.0	.5	4.0	3.5	5.0	9.5	3.5	5.5
n-Pentane	1.5	.5	2.0	2.0	1.5	2.0	3.5	2.5
Total $\mu g/m^3$	23.5	14.5	39.0	43.5	24.0	37.0	27.0	33.0
NMTHC (ppm)	.2	.2		.2		.3	.2	.2
CO (ppm)	.8	1.0		.9		1.4	1.3	1.2
CH_4 (ppm)	1.6	1.6		1.8		1.6	1.6	1.6
NO_x (ppb)	16			18	12	23	16	21

KEY (see map on previous page):

A-1	Over Malone College at 1000'	(10:30 AM)
A-2	Over Malone College at 5000'	(10:40 AM)
A-3	55 miles upwind, touch and go	(9:40 AM)
A-4	40 miles downwind at 1000'	(11:05 AM)
A-5	Over Malone College at 4500'	(2:10 PM)
A-6	26 miles downwind at 1000'	(3:20 PM)
A-7	36 miles downwind at 1000'	(3:40 PM)
A-8	36 miles downwind at 2000'	(3:45 PM)


AKRON
Spiral
98 102 98 104 95
95
98
98
WOOSTER
MASSILON
30
98
97 96 99 101 101
113
126 140 152 140 136
SALEM
LLIANCE
111 112
118
142
138 118
CANTON
112
108
116
124
123
116
110
112
106
104
105
104
108
99
90
77
98
Carrollton
Salineville
114
121
118
112
0
101
90
88
86
88
92
86 106 104
102
102
102
llersburg
DOVER
NEW PHILADELPHIA
108
105 100 102 98
LIVER
Y
Uhrichsville
STEUBENVILL
Scale
1" = 11.4mi.

Time: 2:00 pm to 4:10 pm
Leg: 2:18 - 3:03 Short downwind
3:03 - 3:48 Long downwind
3:48 - 4:10 Upwind loop
Wind: 280° at 6 mph
Weather: Sunny and hot
Comments: Flight altitude - 1000'

Figure B-39. Afternoon flight path on July 13, 1974.

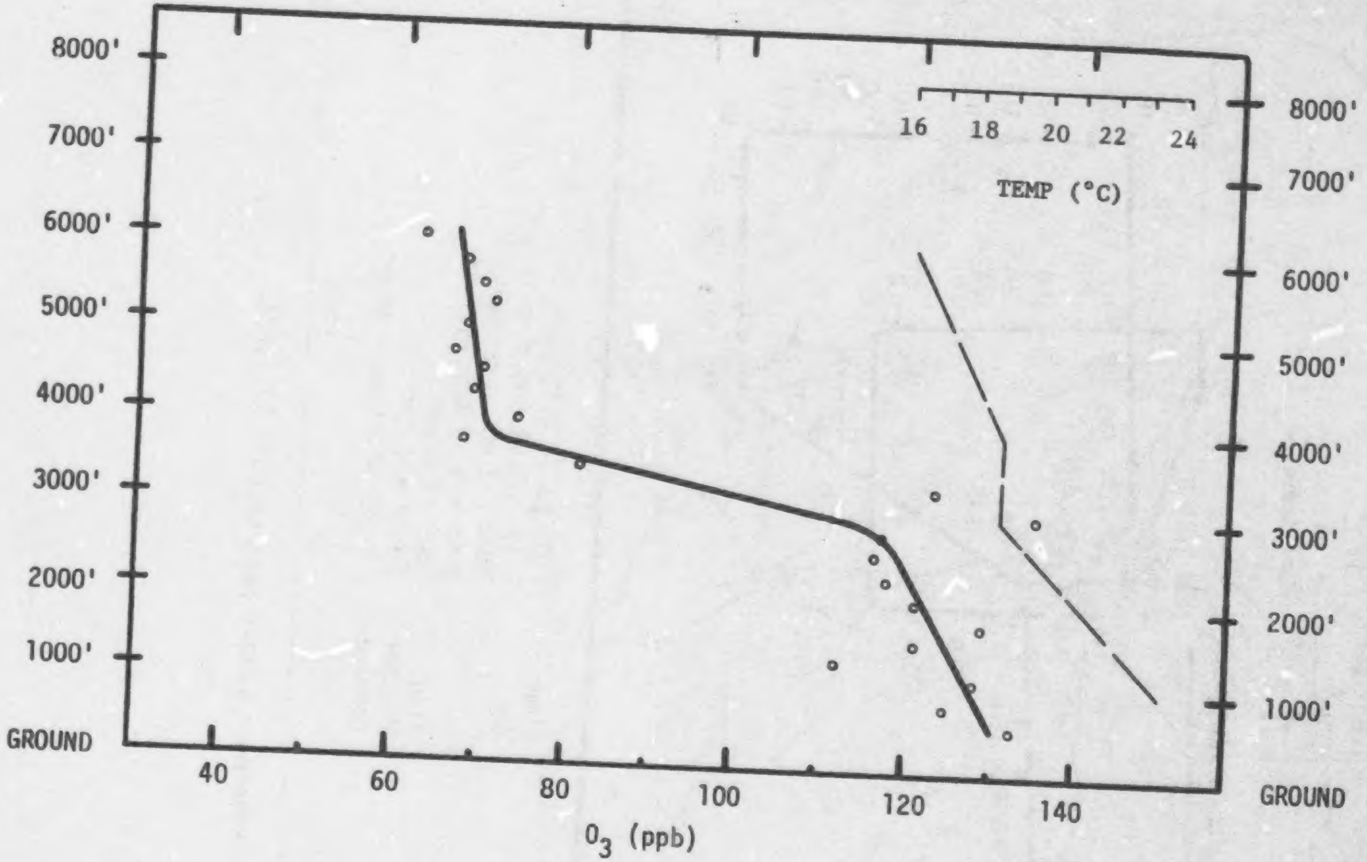
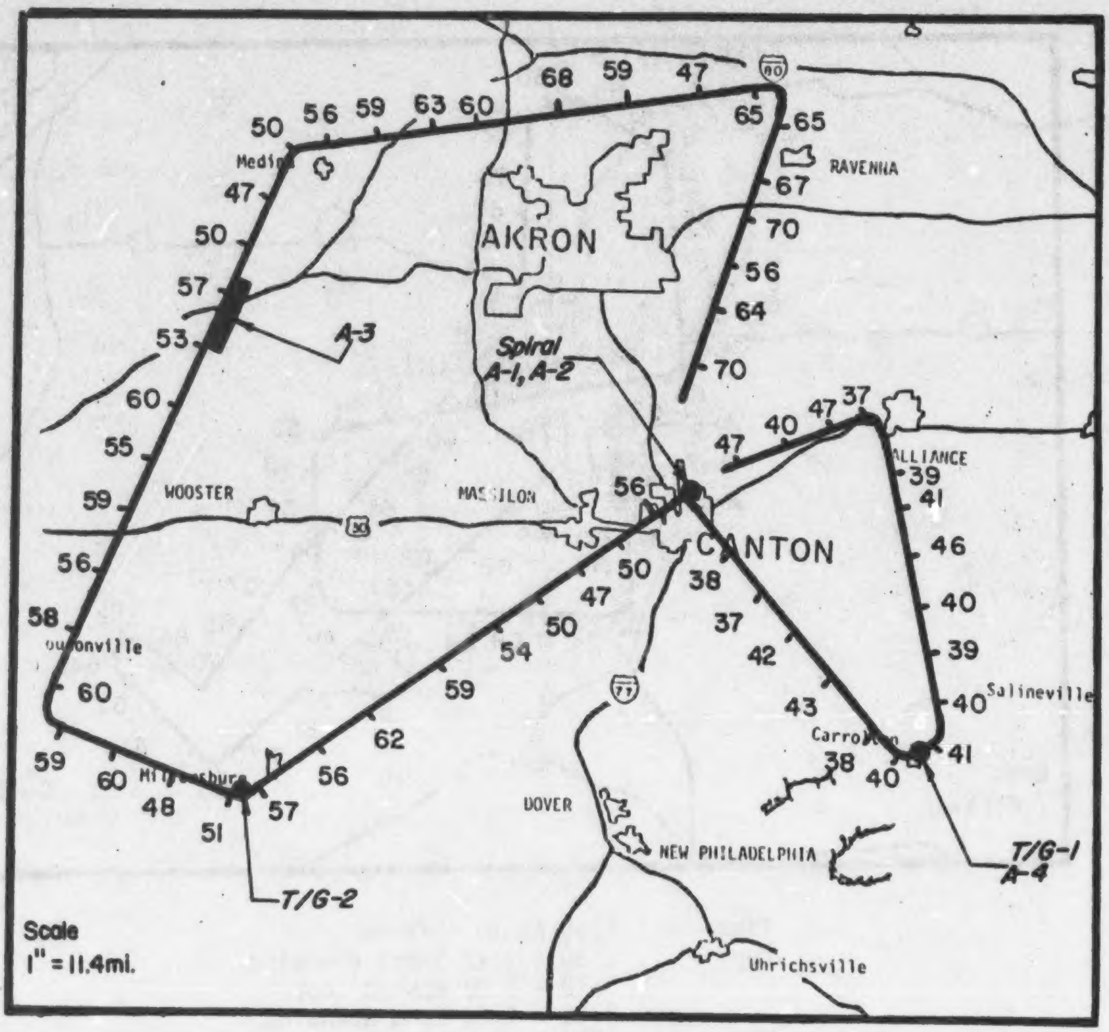
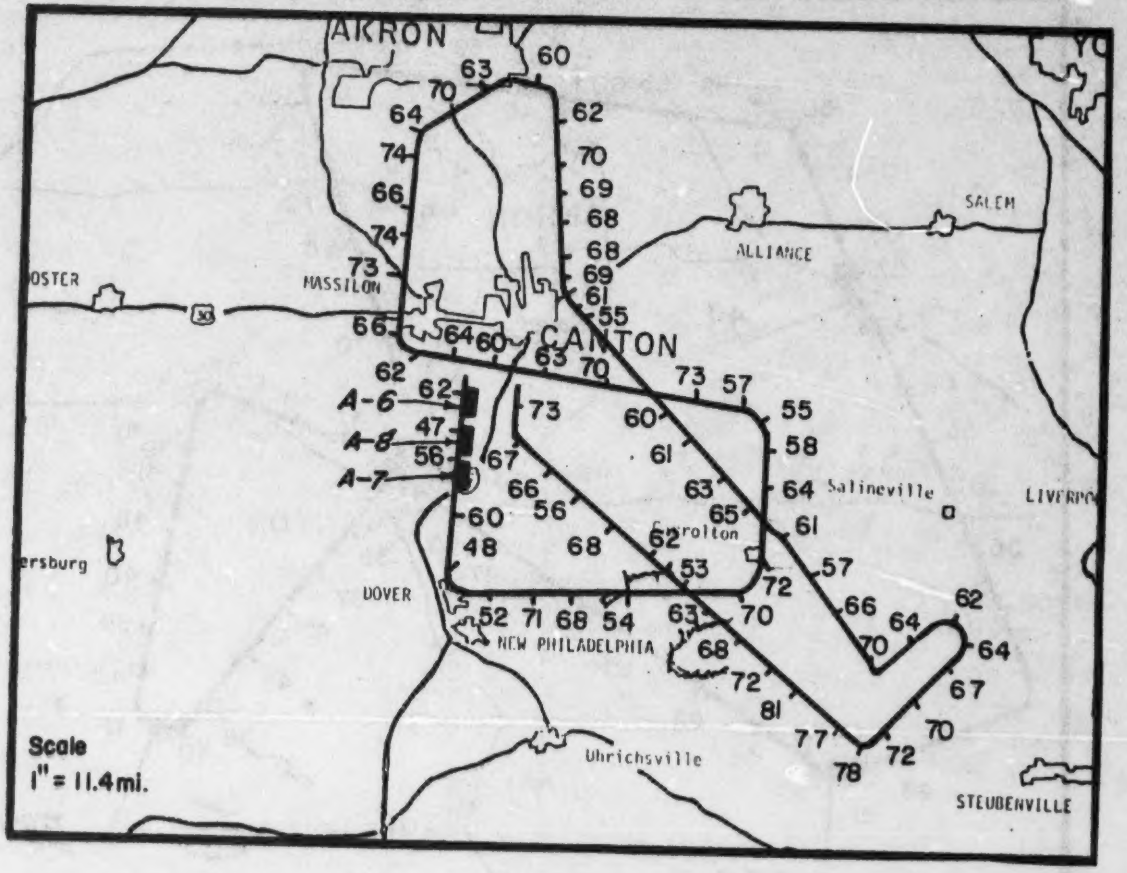


Figure B-40. Spiral climb over Malone College (2:17 pm) on July 13, 1974.


AKRON
RAVENNA
Medina
WOOSTER
MASSILON
CANTON
ALLIANCE
Salineville
Carrollton
DOVER
NEW PHILADELPHIA
Uhrichsville
Orrville
Millersburg
A-3
Spiral
A-1, A-2
T/G-1
A-4
T/G-2
Scale
1" = 11.4mi.
80
30
77
50
56
59
63
60
68
59
47
65
65
67
70
56
64
70
47
50
57
53
60
55
59
56
58
60
59
60
48
51
57
56
62
59
54
50
47
50
56
38
37
42
43
38
40
41
47
40
47
37
39
41
46
40
39
40

Time: 8:50 am to 11:30 am
Leg: 8:55 - 9:37 Downwind loop
10:04 - 11:30 Upwind loop
Wind: 340° at 11 mph
Weather: Cloudy and warm
Comments: Flight altitude - 1000'

Figure B-41. Morning flight path on July 15, 1974.


AKRON
CANTON
MASSILON
ALLIANCE
SALEM
Salineville
LIVERPO
Carrolton
DOVER
NEW PHILADELPHIA
Uhrichsville
STEUBENVILLE
OSTER
ersburg
30
A-6
A-8
A-7
63
60
70
64
62
74
70
66
69
68
74
68
73
69
61
55
66
64
60
63
70
62
73
57
62
55
47
73
60
58
56
61
67
64
66
63
56
65
61
60
62
48
68
53
57
72
52
71
68
54
63
70
66
62
64
68
70
64
72
67
81
70
77
72
78
Scale
1" = 11.4 mi.

Time: 2:30 pm to 4:25 pm
Leg: 2:30 - 3:12 Short downwind
3:12 - 3:32 Upwind loop
3:32 - 4:25 Long downwind
Wind: 350° at 17 mph
Weather: Sunny and hot
Comments: Flight altitude 1000'

Figure B-42. Afternoon flight path on July 15, 1974.

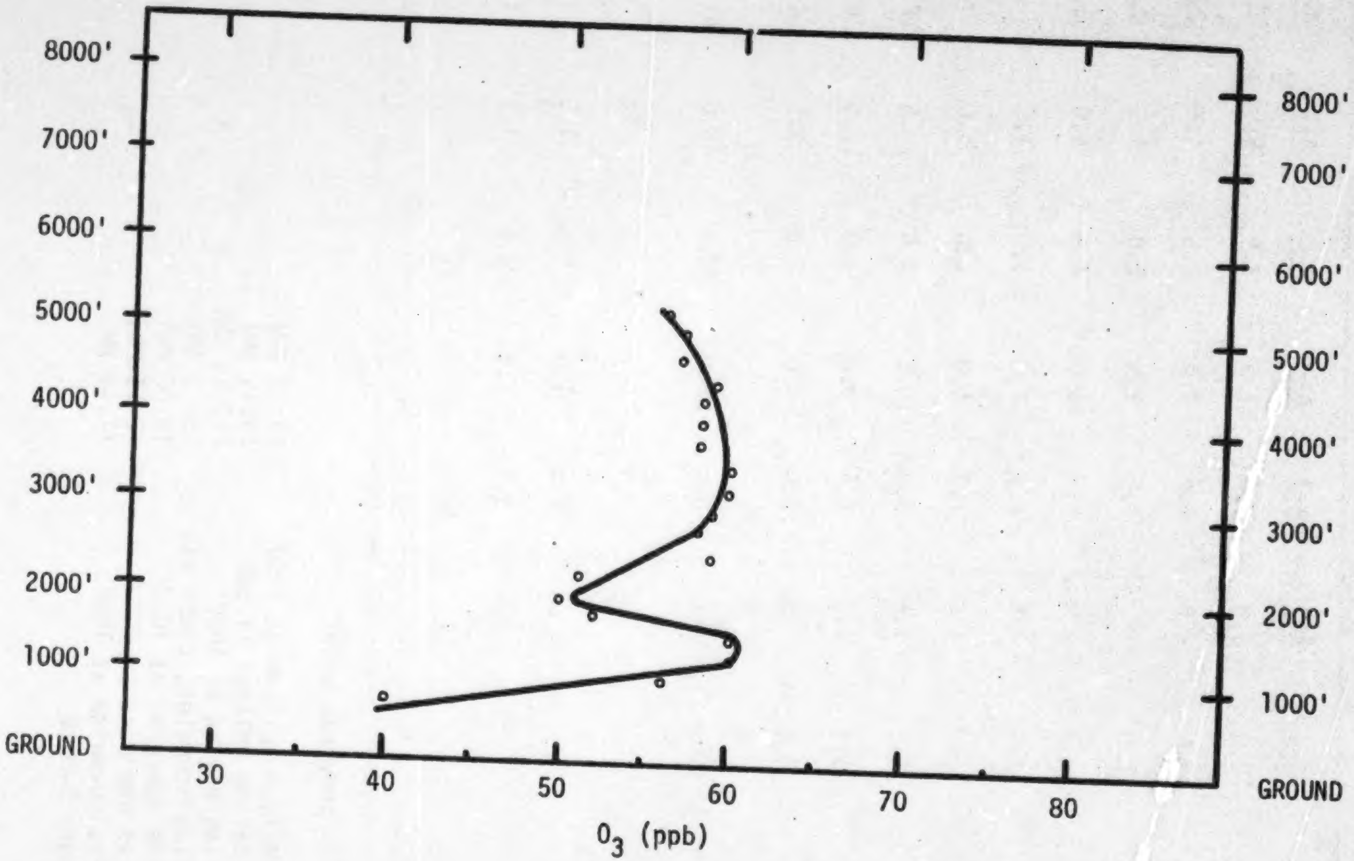


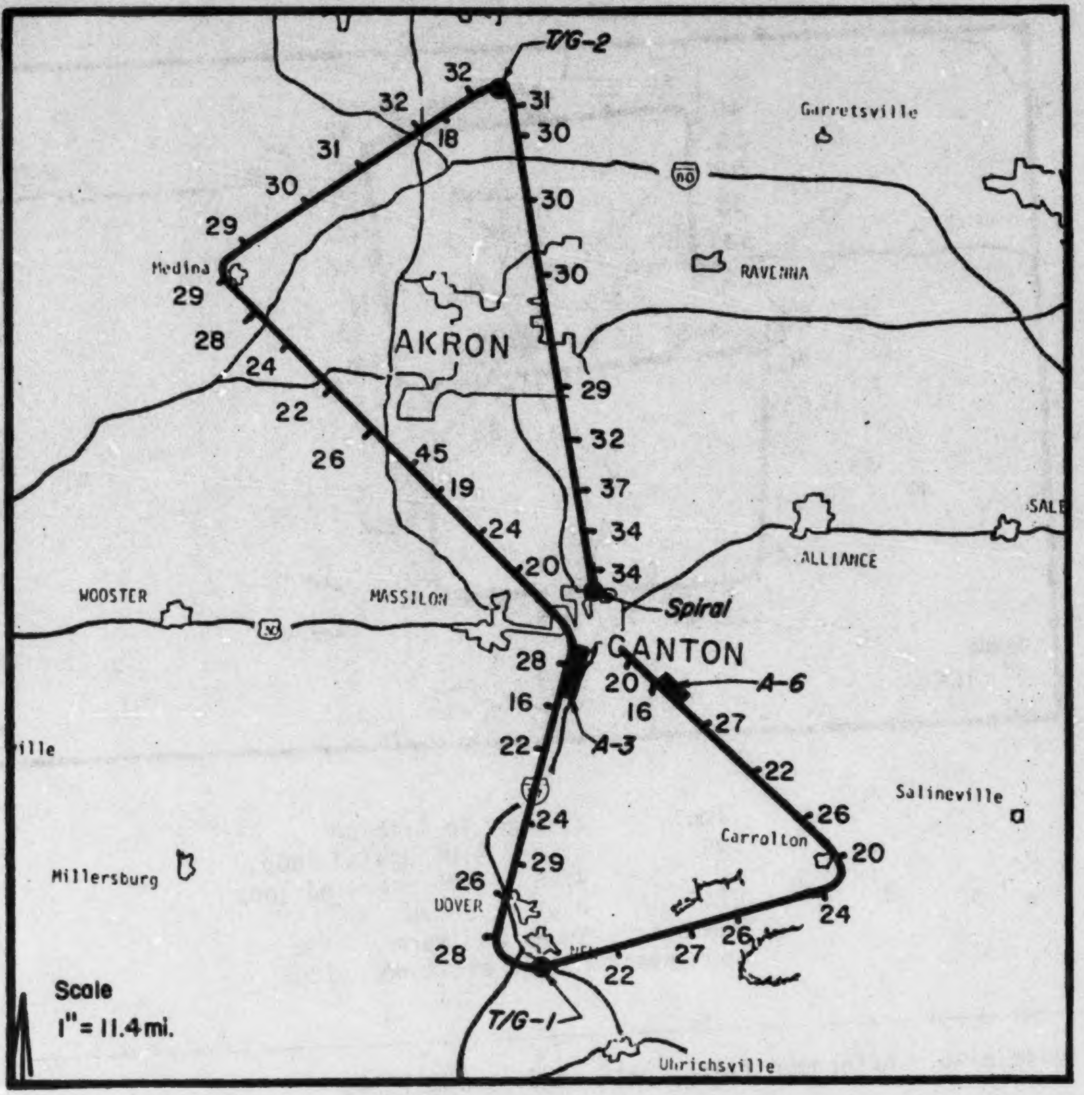
Figure B-43. Spiral climb over Malone College (10:05 am) on July 15, 1974.

TABLE B-12. AIRCRAFT COLLECTED BAG SAMPLES. JULY 15, 1974.

	A-1	A-2	A-3	A-4	A-6	A-7	A-8
Ethane	10.0	5.0	8.5	17.0	7.5	5.0	3.0
Ethylene	13.5	2.0	4.5	4.0	6.5	4.5	2.0
Acetylene	3.0	*	1.5	2.5	2.0	1.5	1.0
Propane	6.5	3.0	5.5	16.0	4.5	5.0	3.0
Propene	2.5	.5	1.5	1.0	1.0	1.5	.5
i-Butane	3.0	1.0	1.5	5.0	2.0	5.0	9.0
n-Butane	6.5	1.5	3.0	10.5	4.0	10.5	12.5
i-Pentane	11.5	1.5	2.5	8.0	4.0	12.5	26.0
n-Pentane	3.5	.5	1.5	4.0	2.0	2.5	4.0
Total $\mu g/m^3$	60.0	15.0	3.0	68.0	33.5	48.0	61.0
NMTHC (ppm)		.3	.3	.7	.3	.3	.4
CO (ppm)		.9	1.2	1.3	1.5	1.5	1.3
CH_4 (ppm)		1.5	1.7	1.9	1.6	1.7	1.6
NO_x (ppb)		12	18		17	12	

KEY (see map on previous page):

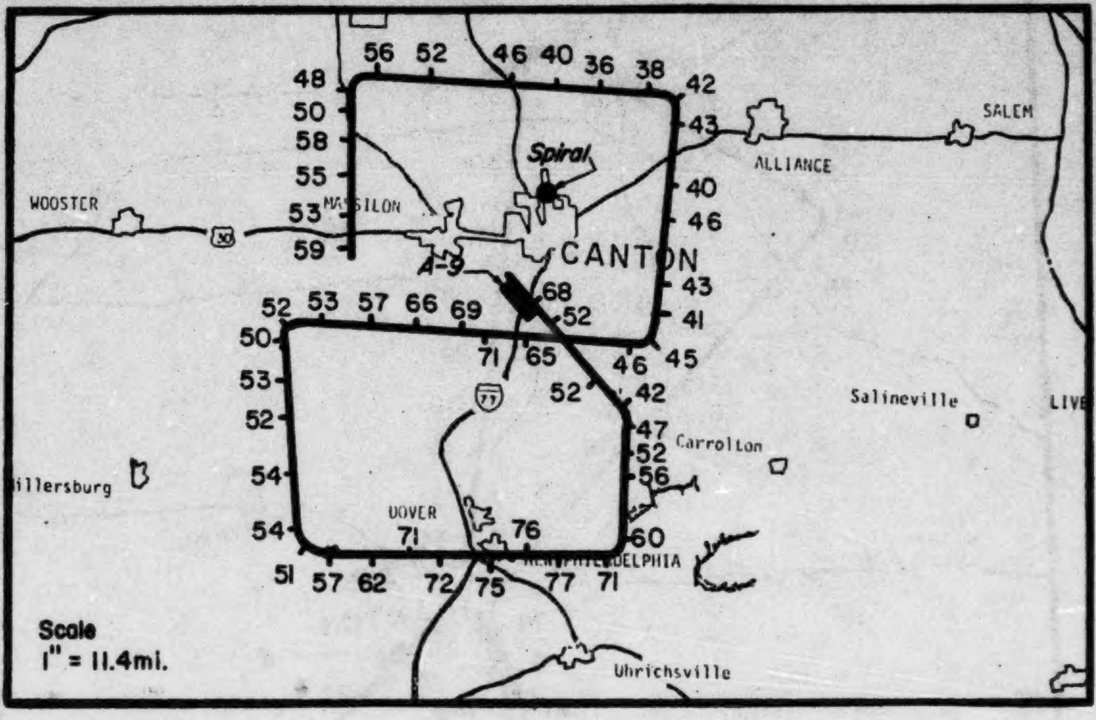
A-1	Over Malone College at 1000'	(9:35 AM)
A-2	Over Malone College at 5000'	(9:45 AM)
A-3	40 miles upwind at 1000'	(10:45 AM)
A-4	20 miles downwind, touch and go	(9:15 AM)
A-6	4 miles downwind at 1000'	(2:00 PM)
A-7	8 miles downwind at 1000'	(2:15 PM)
A-8	6 miles downwind at 1000'	(1:45 PM)
A-5	Refinery Sample	


T/G-2
32
32
31
18
31
30
30
30
29
Garretsville
80
RAVENNA
Medina
29
28
24
AKRON
22
26
45
19
24
20
29
32
37
34
34
Spiral
SALE
ALLIANCE
WOOSTER
MASSILON
CANTON
28
20
A-6
16
16
27
22
A-3
22
ille
22
24
Salineville
26
Carrolton
20
Millersburg
29
26
DOVER
24
26
27
28
22
NEW
T/G-1
Uhrichsville
Scale
1" = 11.4 mi.

Time: 8:55 am to 11:30 am
Leg: 9:03 - 9:47 Downwind loop
9:47 - 10:28 Upwind loop
Comments: Flight altitude - 1000'

Wind: 350° at 10 mph
Weather: Sunny and cool

Figure B-44. Morning flight path on July 16, 1974.


56
52
46
40
36
38
42
48
50
58
55
53
59
43
40
46
43
41
45
Spiral
SALEM
ALLIANCE
WOOSTER
MASSILON
30
CANTON
A-9
68
52
52
53
57
66
69
50
71
65
46
53
52
42
77
52
54
54
47
52
56
60
Salineville
LIVE
Carrolton
illersburg
DOVER
71
76
NEW PHILADELPHIA
51
57
62
72
75
77
71
Uhrichsville
Scale
1" = 11.4mi.

Time: 2:15 pm to 4:45 pm
Leg: 3:36 - 4:06 Upwind loop
4:06 - 4:45 Downwind loop
Wind: 030° at 5 mph
Weather: Sunny and warm
Comments: Flight altitude - 1000'

Figure B-45. Afternoon flight path on July 16, 1974.

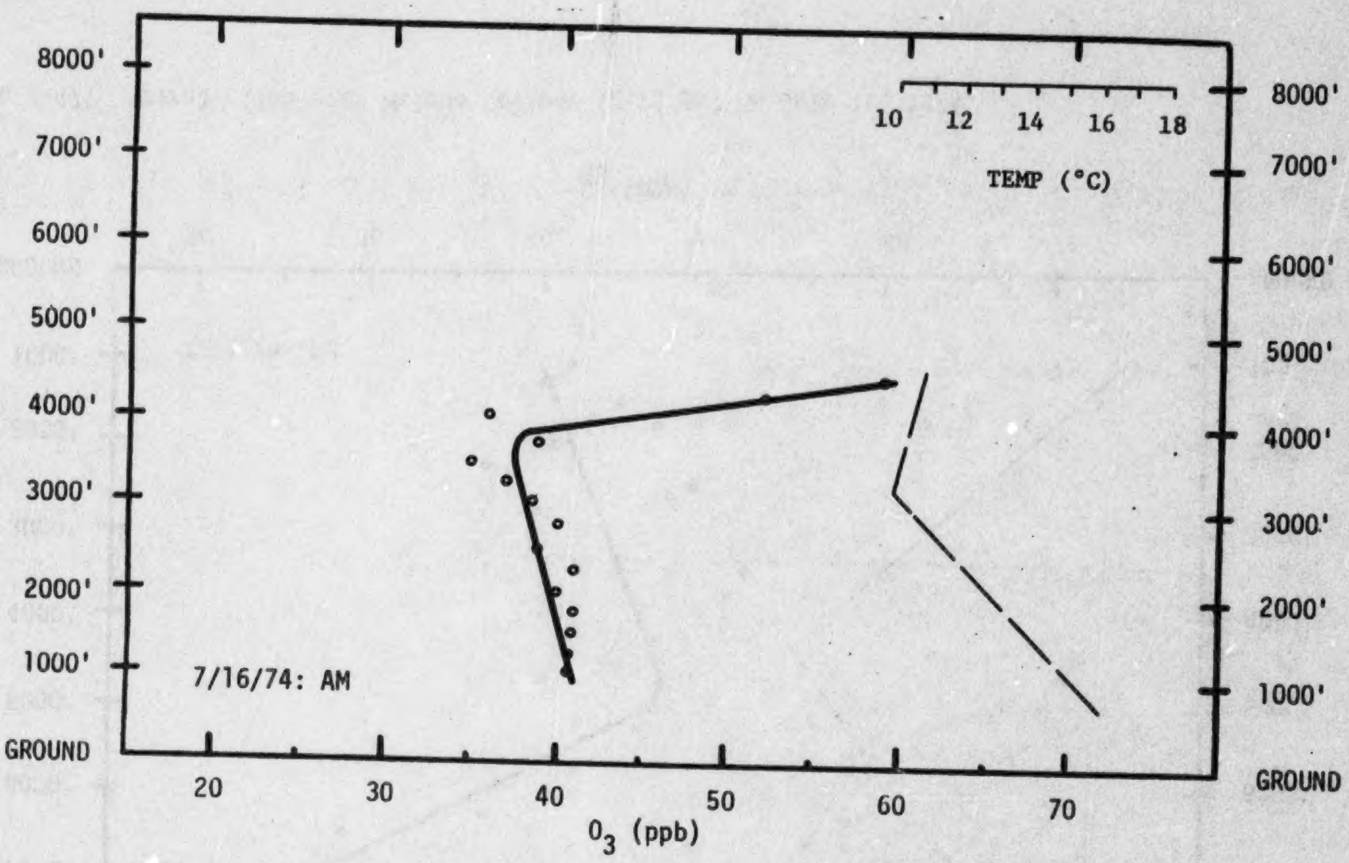


Figure B-46. Spiral climb over Malone College (11:02 am) on July 16, 1974.

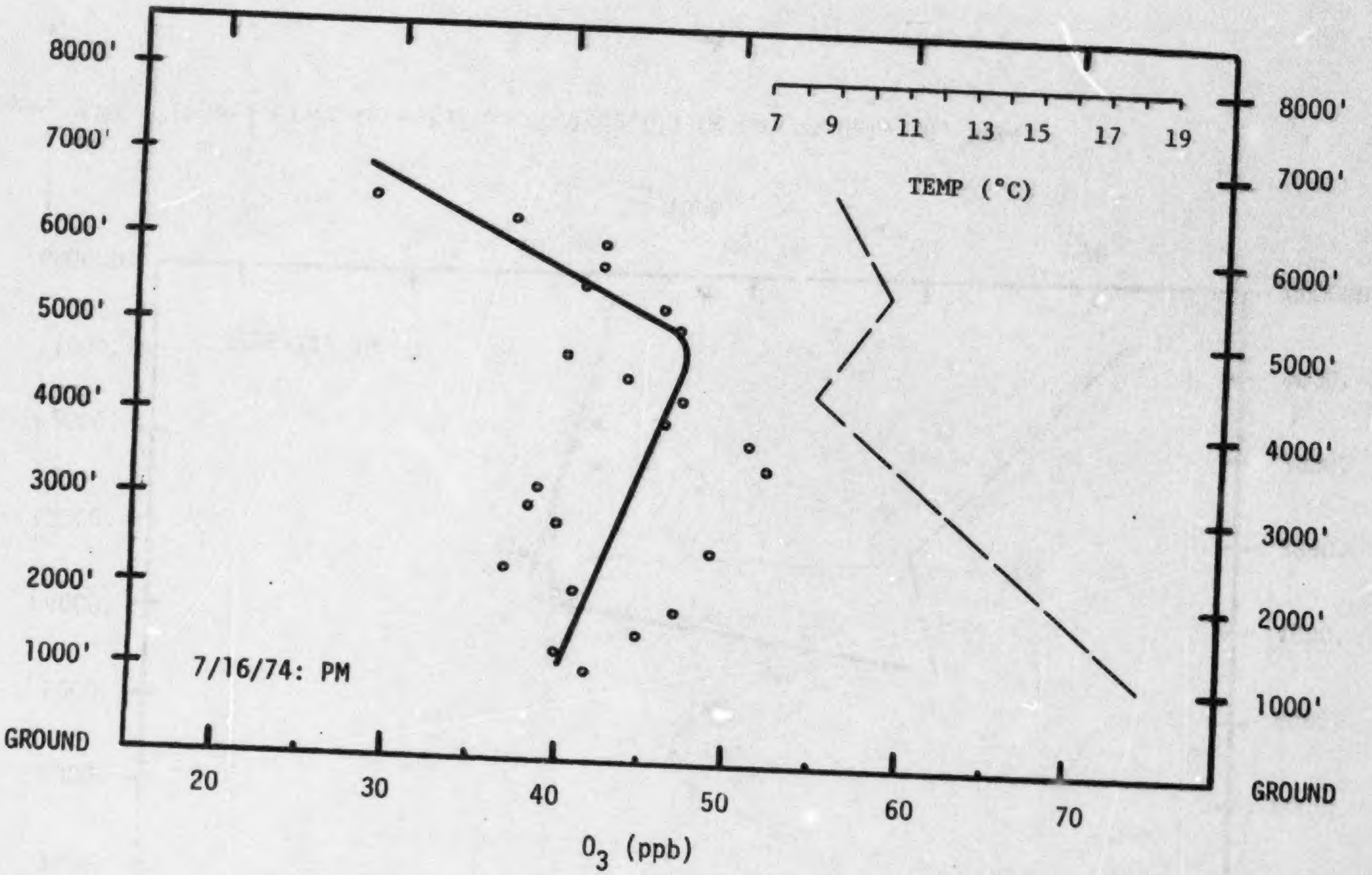


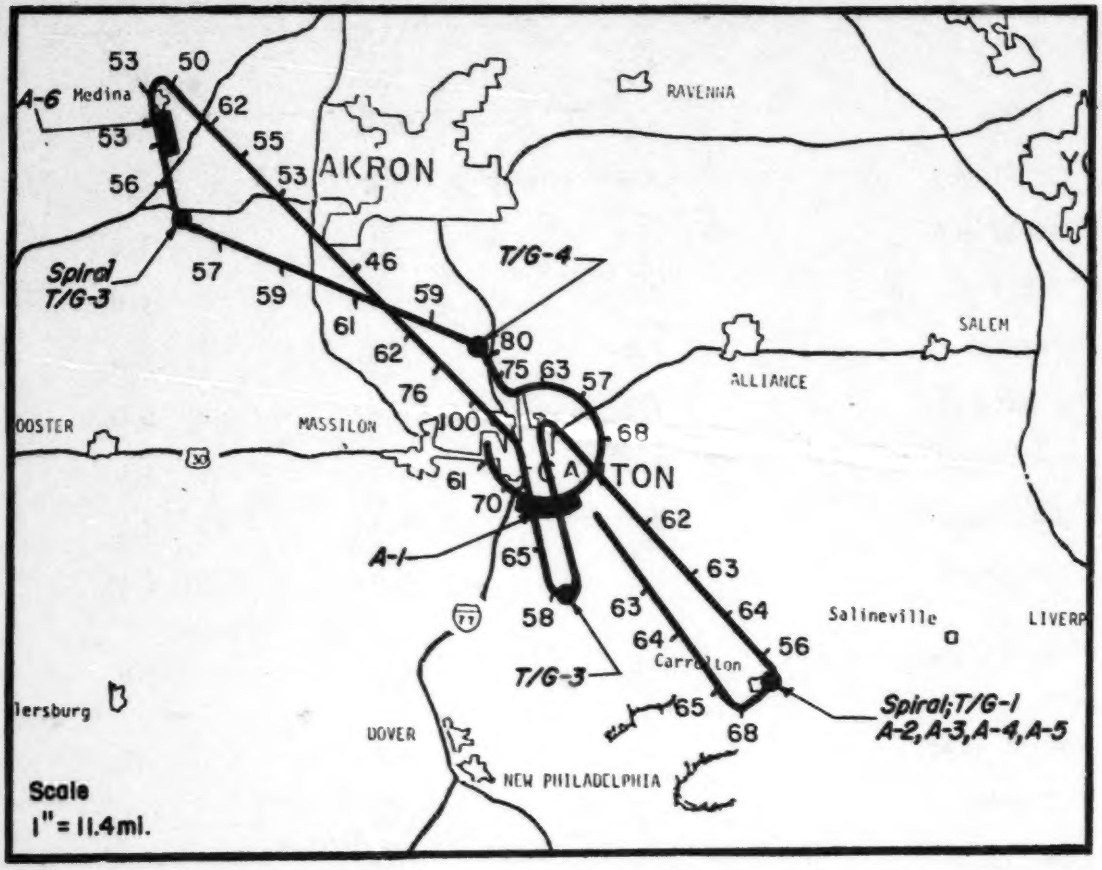
Figure B-47. Spiral climb over Malone College (2:28 pm) on July 16, 1974.

TABLE B-13. AIRCRAFT COLLECTED BAG SAMPLES. JULY 16, 1974.

	A-3	A-6	A-9
Ethane	5.5	6.5	6.5
Ethylene	4.0	5.0	4.5
Acetylene	*	2.5	1.0
Propane	2.5	4.0	4.0
Propene	2.0	1.0	2.0
i-Butane	1.5	3.5	5.0
n-Butane	2.0	6.5	4.0
i-Pentane	3.5	6.5	4.0
n-Pentane	1.5	3.0	1.5
Total μg/m^3	22.5	38.5	32.5
NMTHC (ppm)	.2	.3	.2
CO (ppm)	.7	1.3	1.1
CH_4 (ppm)	1.6	1.7	1.6
NO_x (ppb)	9		17

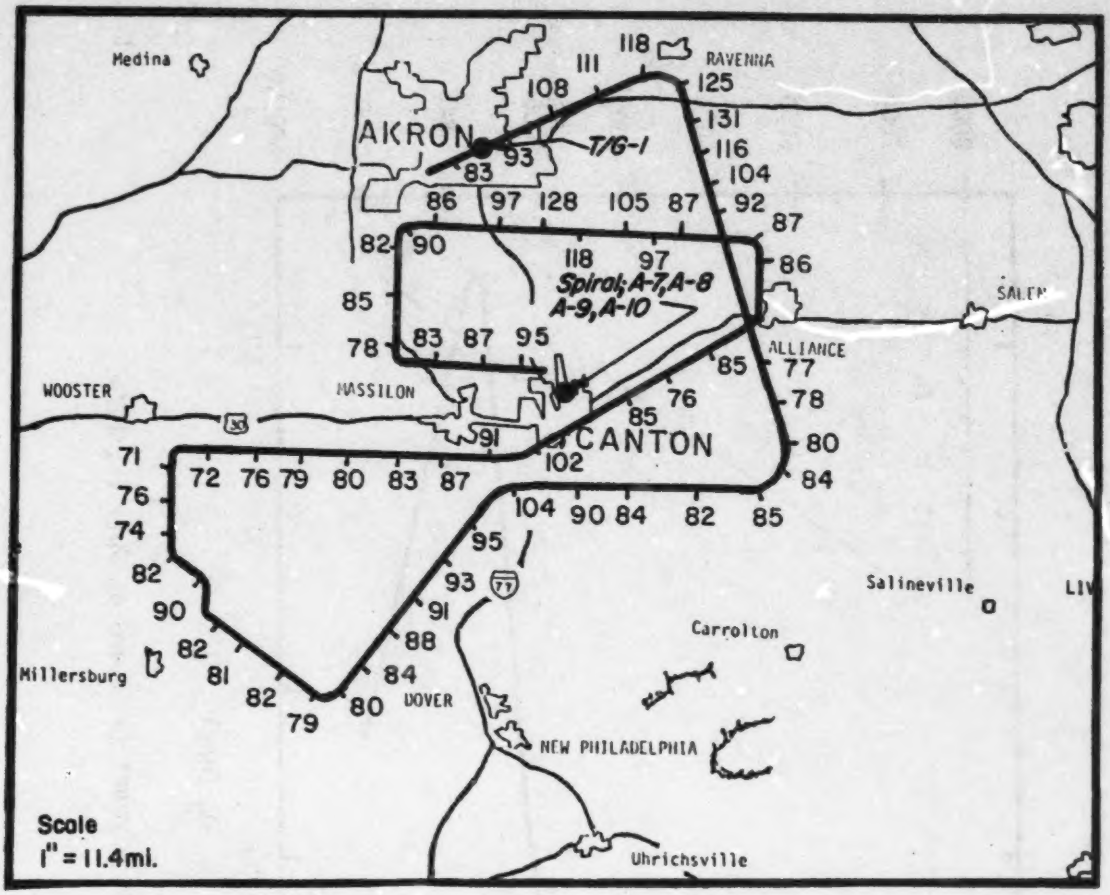
KEY (see map on previous page):

A-3	Over Southwest Canton at 4500'	(10:45 AM)
A-6	6 miles downwind at 1000'	(11:25 AM)
A-9	7 miles downwing at 1000'	(3:15 PM)
A-1,2,4,5,7,8	Refinery Samples	


53
50
A-6
Medina
62
53
55
56
53
AKRON
RAVENNA
Y
Spiral T/G-3
57
59
46
T/G-4
59
61
62
180
SALEM
75
63
57
ALLIANCE
76
OOSTER
MASSILON
100
68
30
61
CANTON
70
62
A-1
65
63
77
58
63
64
Salineville
LIVERP
64
56
Carrollton
T/G-3
Spiral;T/G-1
A-2,A-3,A-4,A-5
65
lersburg
68
DOVER
NEW PHILADELPHIA
Scale
1" = 11.4mi.

Time: 9:00 am to 11:45 am
Leg: 9:05 - 10:05 Southeast loop
10:05 - 10:20 South loop
10:20 - 11:30 Northwest loop
11:30 - 11:45 City circle
Wind: Variable at 2 mph
Weather: Sunny
Comments: Flight altitude - 1000'

Figure B-48. Morning flight path on July 17, 1974.


Medina
118
RAVENNA
111
108
125
131
AKRON
T/G-1
116
93
83
104
86
97
128
105
87
92
87
82
90
118
97
86
Spiral; A-7, A-8
A-9, A-10
SALEM
85
78
83
87
95
ALLIANCE
85
77
WOOSTER
MASSILON
76
78
85
91
CANTON
80
71
102
72
76
79
80
83
87
84
76
104
90
84
82
85
74
95
82
93
Salineville
LIV
90
91
Carrolton
88
82
Millersburg
81
84
82
79
80
DOVER
NEW PHILADELPHIA
Scale
1" = 11.4mi.
Uhrichsville

Time: 2:15 pm to 4:30 pm
Leg: 2:49 - 3:21 Short NE loop
3:21 - 3:54 SW loop
3:54 - 4:30 Long NE loop
Wind: Variable at 5 mph
Weather: Sunny and hot
Comments: Flight altitude - 1000'

Figure B-49. Afternoon flight path on July 17, 1974.

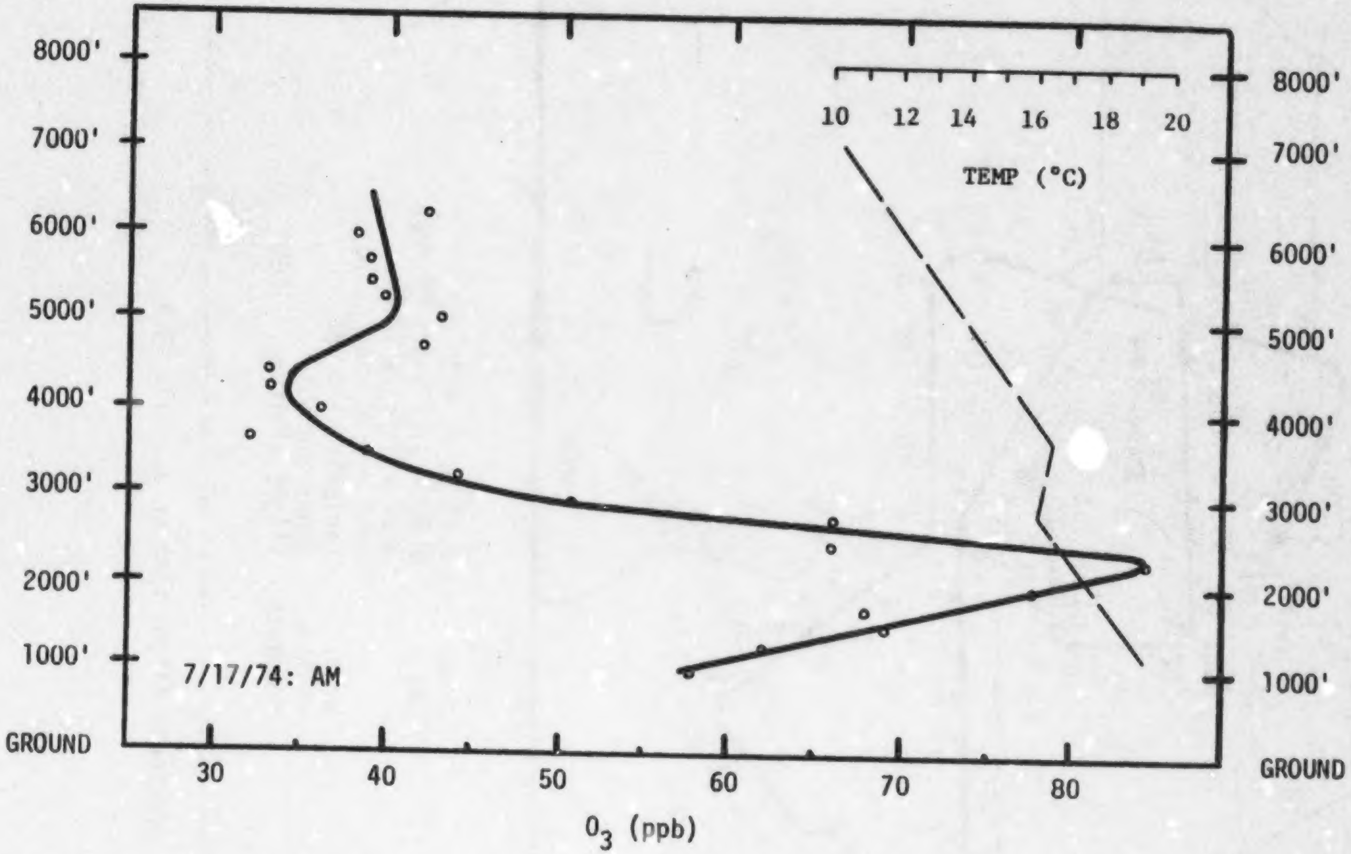


Figure B-50. Spiral climb over Carroll Co. Airport (9:52 am) on July 17, 1974.

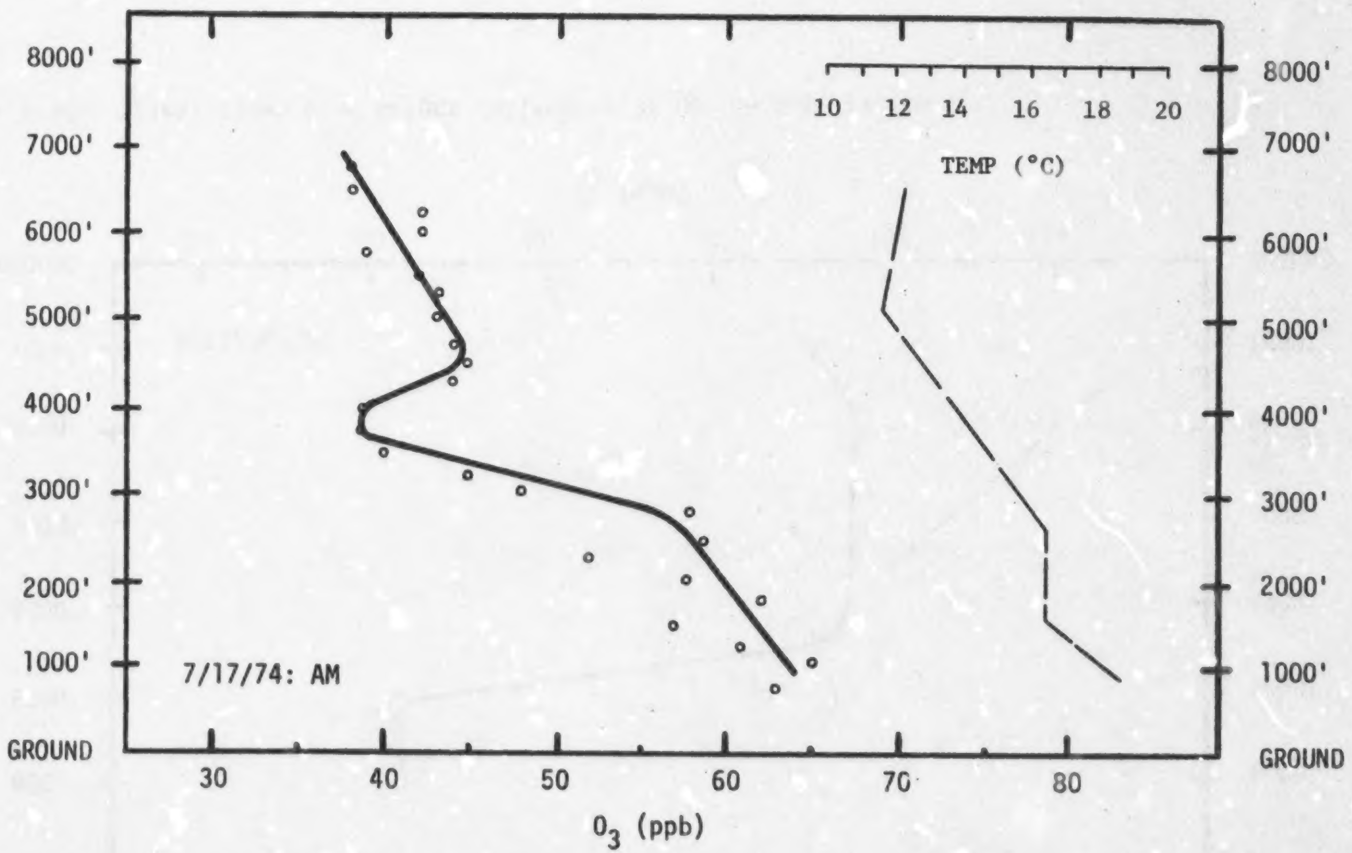


Figure B-51. Spiral climb over Weltzien Airport (11:14 am) on July 17, 1974.

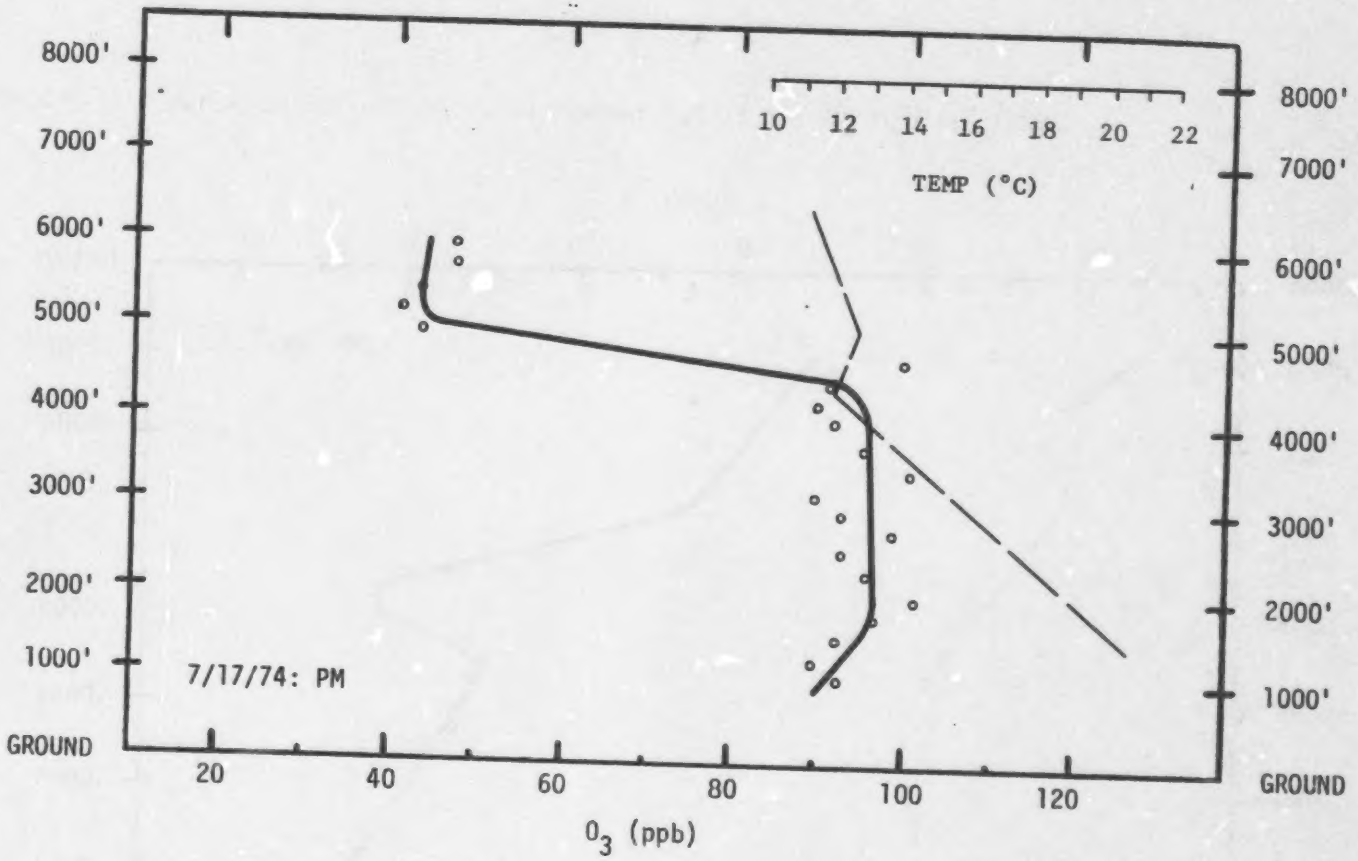


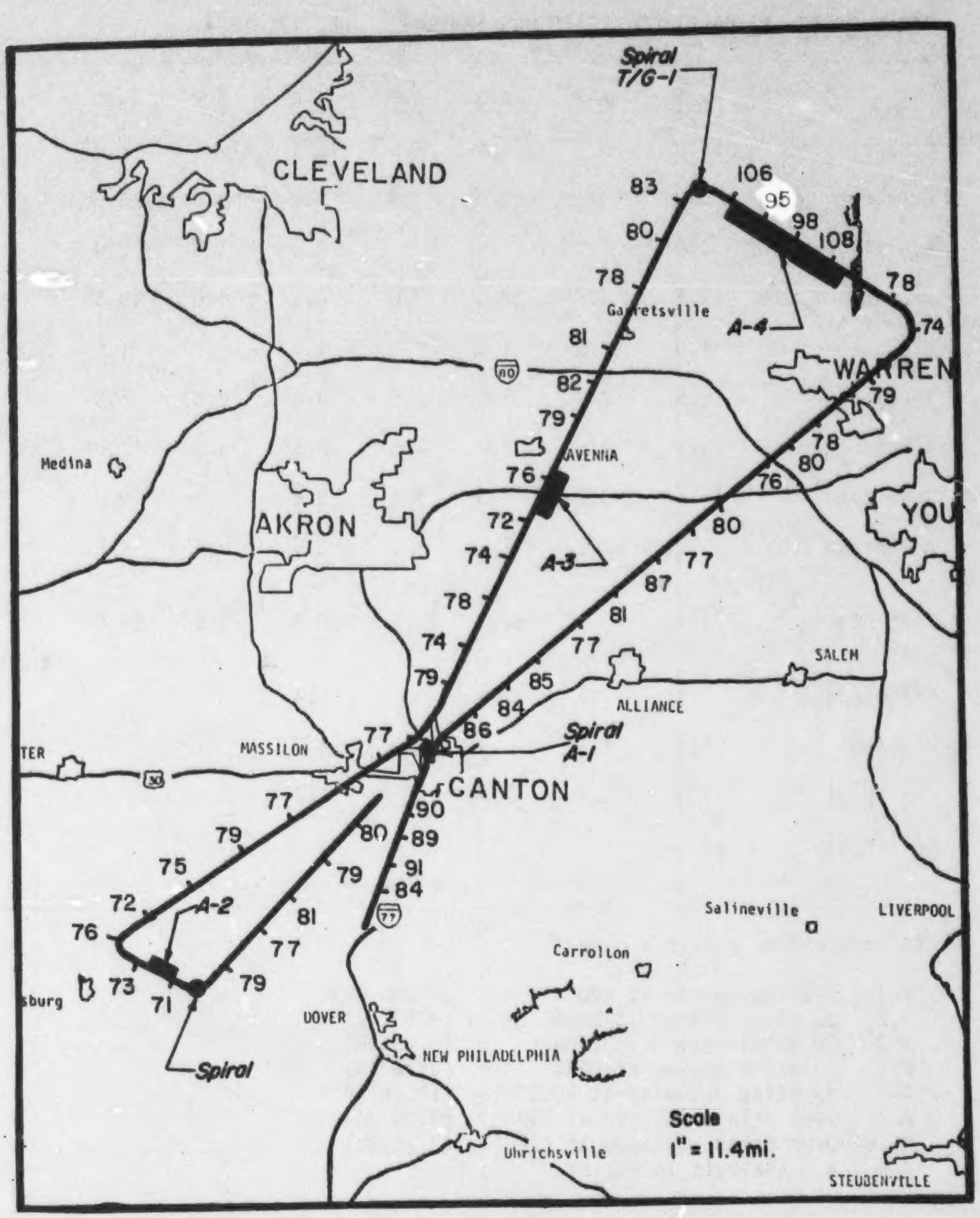
Figure B-52. Spiral climb over Malone College (2:31 pm) on July 17, 1974.

TABLE B-14. AIRCRAFT COLLECTED BAG SAMPLES. JULY 17, 1974.

	A-1	A-2	A-3	A-5	A-6	A-9	A-10
Ethane	14.0		6.5	7.5	10.5	17.5	8.0
Ethylene	5.0		3.0	3.5	5.0	4.5	4.0
Acetylene	1.0	1.5	.5	*	2.0	1.5	2.0
Propane	17.5	4.5	3.0	3.0	6.5	11.0	10.5
Propene	1.0	.5	1.0	1.0	1.5	2.0	1.0
i-Butane	6.5	2.0	1.5	2.5	4.0	8.0	5.5
n-Butane	12.0	4.5	2.0	3.5	8.5	14.5	11.0
i-Pentane	11.5	3.5	2.5	3.5	9.5	11.0	9.0
n-Pentane	5.0	3.0	1.0	1.5	2.5	6.0	4.5
Total $\mu g/m^3$	73.5		21.0	26.0	50.0	76.0	55.5
NMTHC (ppm)	.4	.5	.4		.4		
CO (ppm)	1.0	1.0	.9		1.2		
CH_4 (ppm)	1.8	1.7	1.7		1.7		
NO_x (ppb)	26				14		

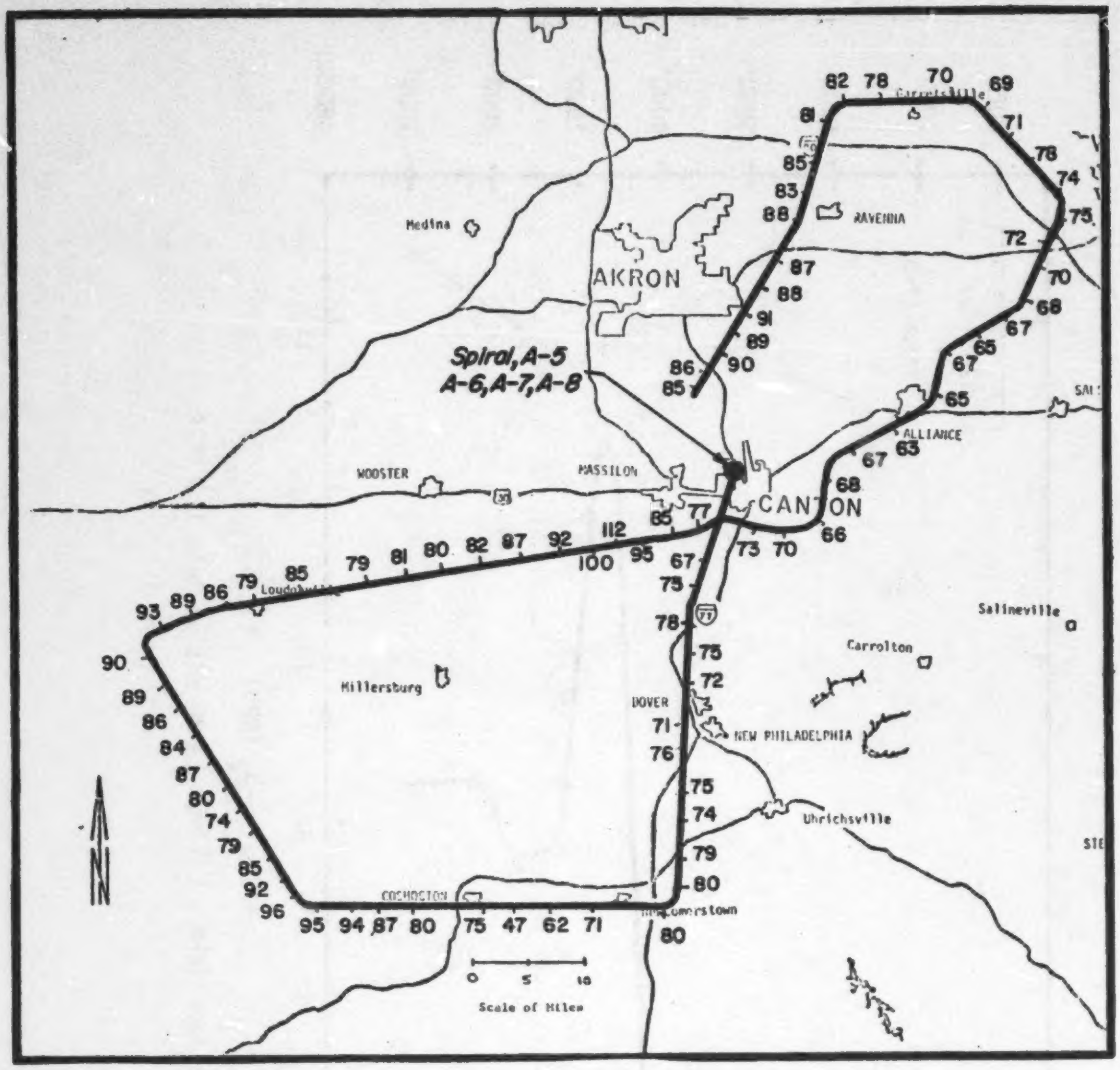
KEY (see map on previous page):

A-1	5 miles upwind at 800'	(11:40 AM)
A-2	20 miles upwind at 2200'	(9:50 AM)
A-3	20 miles upwind at 2600'	(9:45 AM)
A-5	20 miles upwind at 6000'	(9:30 AM)
A-6	34 miles downwind at 1000'	(10:40 AM)
A-9	Over Malone College at 3300'	(2:25 PM)
A-10	Over Malone College at 4300'	(2:15 PM)
A-4,7,8	Analysis Incomplete	


Spiral
T/G-1
CLEVELAND
83
106
95
98
108
80
78
Garretsville
A-4
78
74
81
82
WARREN
79
79
Medina
RAVENNA
78
80
76
76
YOU
AKRON
72
80
74
A-3
77
87
78
81
SALEM
74
77
79
85
ALLIANCE
84
86
Spiral
A-1
TER
MASSILON
77
CANTON
77
90
80
89
79
79
75
91
84
72
A-2
81
Salineville
LIVERPOOL
76
77
Carrollton
73
79
sburg
71
DOVER
Spiral
NEW PHILADELPHIA
Scale
1" = 11.4mi.
Uhrichsville
STEUBENVILLE

Time:	8:50 am to 11:50 am	Wind:	250° at 9 mph
Leg:	9:13 - 9:32 Upwind loop	Weather:	Cloudy and cool
	9:32 - 11:01 Downwind loop	Comments:	Flight altitude - 1000' except South leg at 3000'
	11:01 - 11:24 South leg		

Figure B-53. Morning flight path on July 18, 1974.


Spiral, A-5
A-6, A-7, A-8
Medina
AKRON
RAVENNA
Garrettsville
ALLIANCE
WOOSTER
MASSILON
CANTON
Loudonville
Millersburg
DOVER
NEW PHILADELPHIA
Carrolton
Salineville
Uhrichsville
COSHOCTON
Newcomerstown
82
78
70
69
81
71
85
76
83
74
88
75
72
87
70
88
68
91
67
89
65
86
90
67
85
65
67
63
68
66
85
77
73
70
112
92
87
82
80
81
79
85
79
86
89
93
100
95
67
75
78
75
72
71
76
75
74
79
80
80
90
89
86
84
87
80
74
79
85
92
96
95
94
87
80
75
47
62
71
0
5
10
Scale of Miles
N

Time: 1:50 pm to 4:45 pm
Leg: 2:26 - 3:55 Upwind loop Wind: 220° at 10 mph
3:55 - 4:45 Downwind loop Weather: Hot with scattered clouds
Comments: Flight altitude - 1000'. Passed through power plant plume on southern most leg (75-47-62-71).

Figure B-54. Afternoon flight path on July 18, 1974.

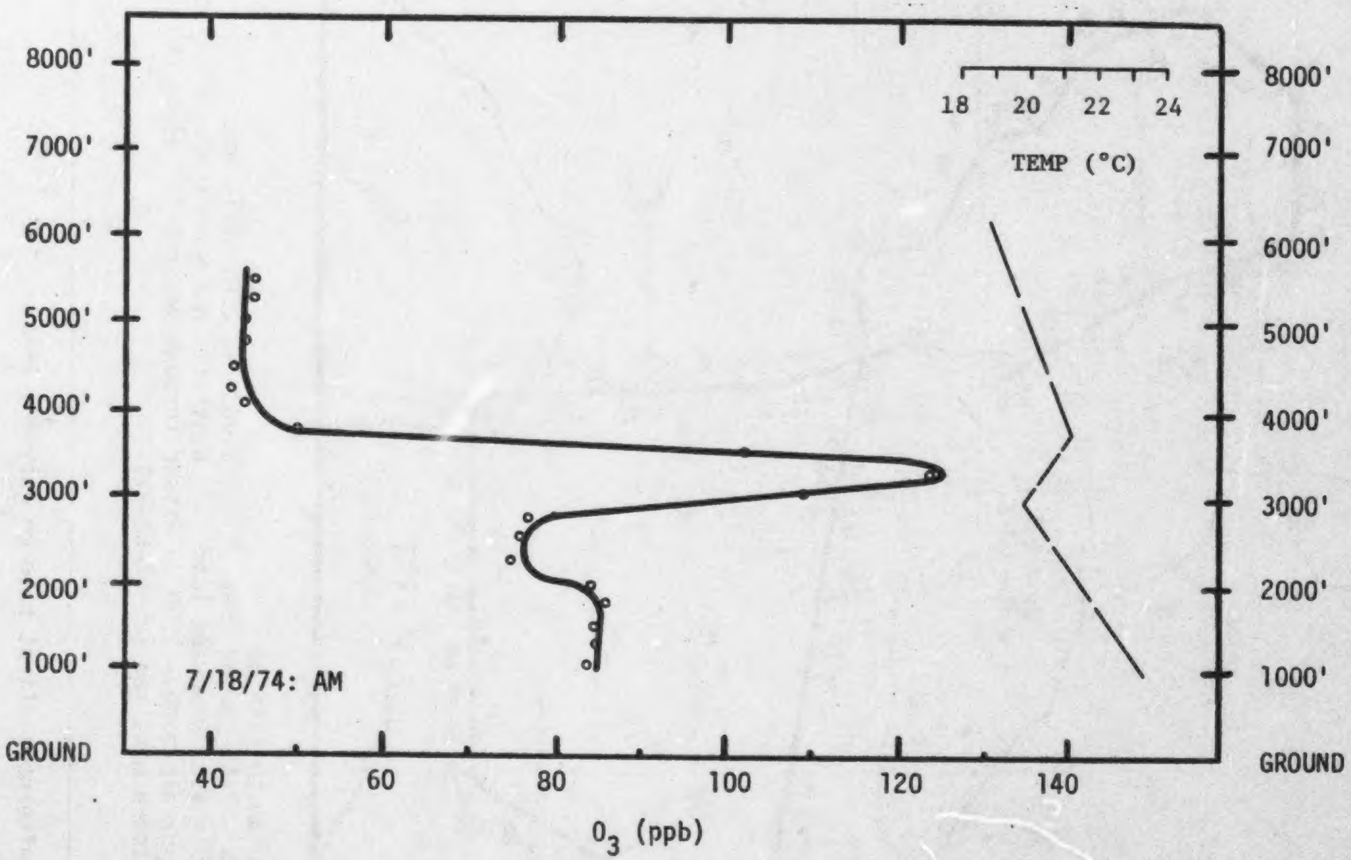


Figure B-55. Spiral climb over Malone College (9:30 am) on July 18, 1974.

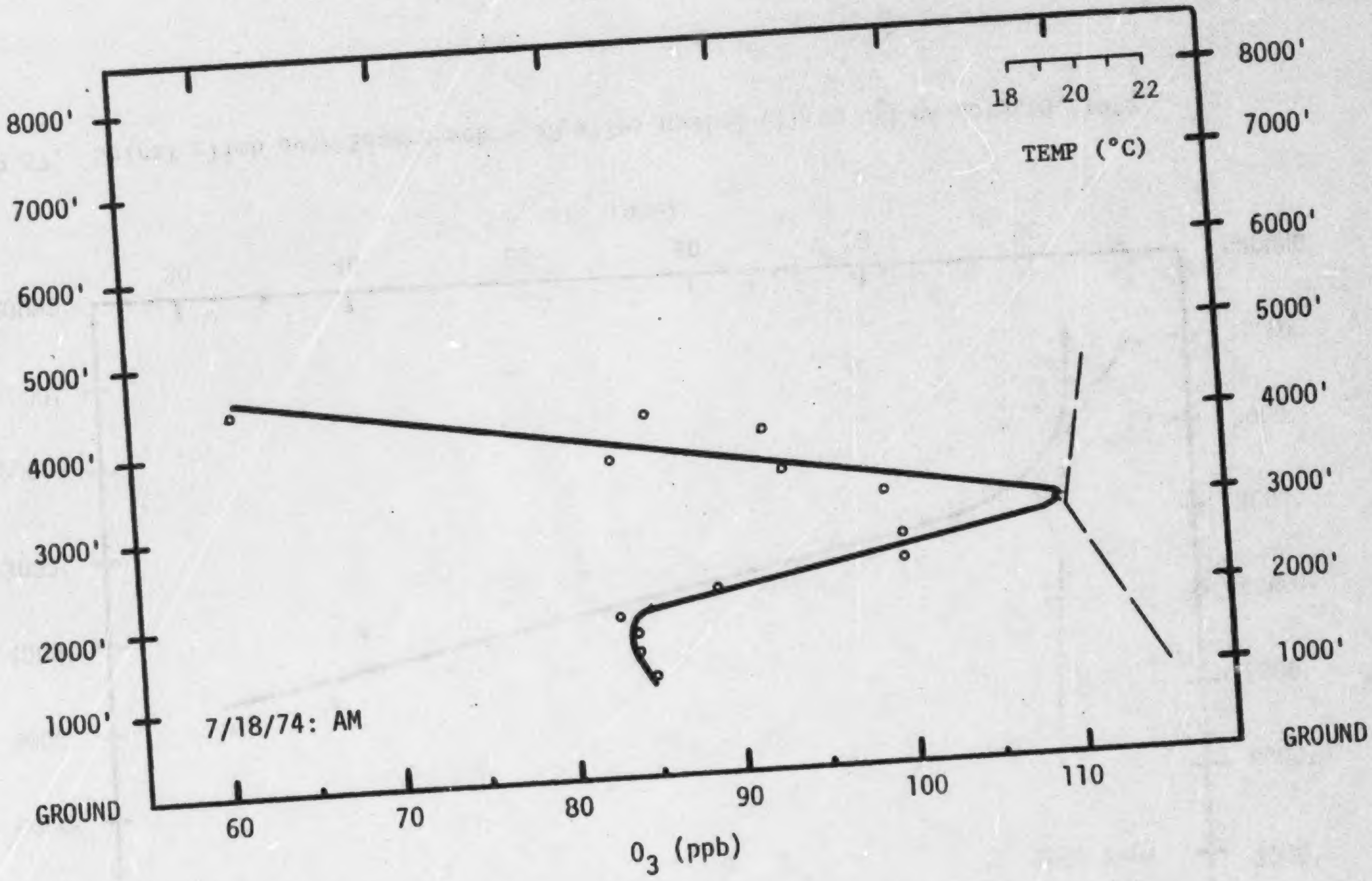


Figure B-56. Spiral climb over Courtland - 50 miles downwind (10:31 am) on July 18, 1974.

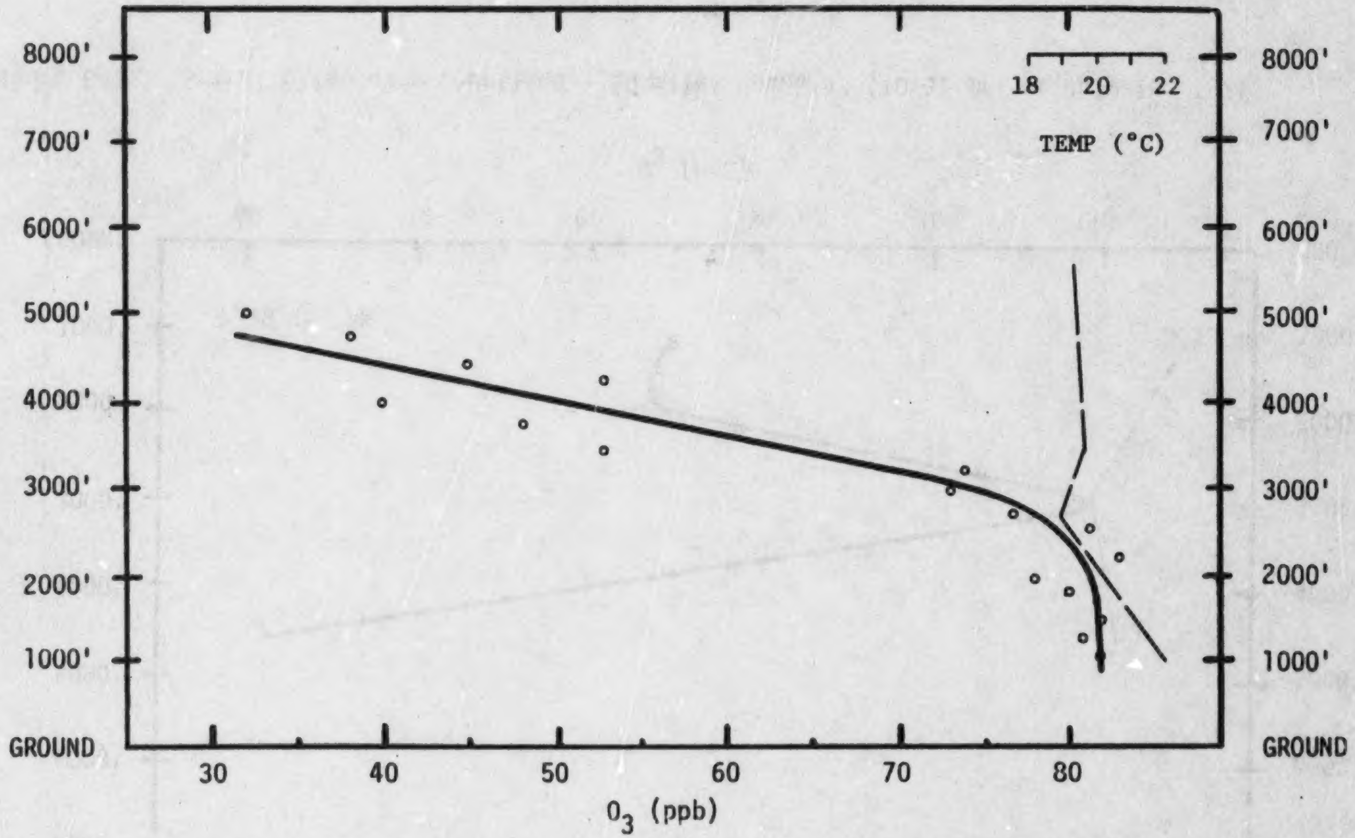


Figure B-57. Spiral climb over Sugarcreek - 30 miles upwind (11:40 am) on July 18, 1974.

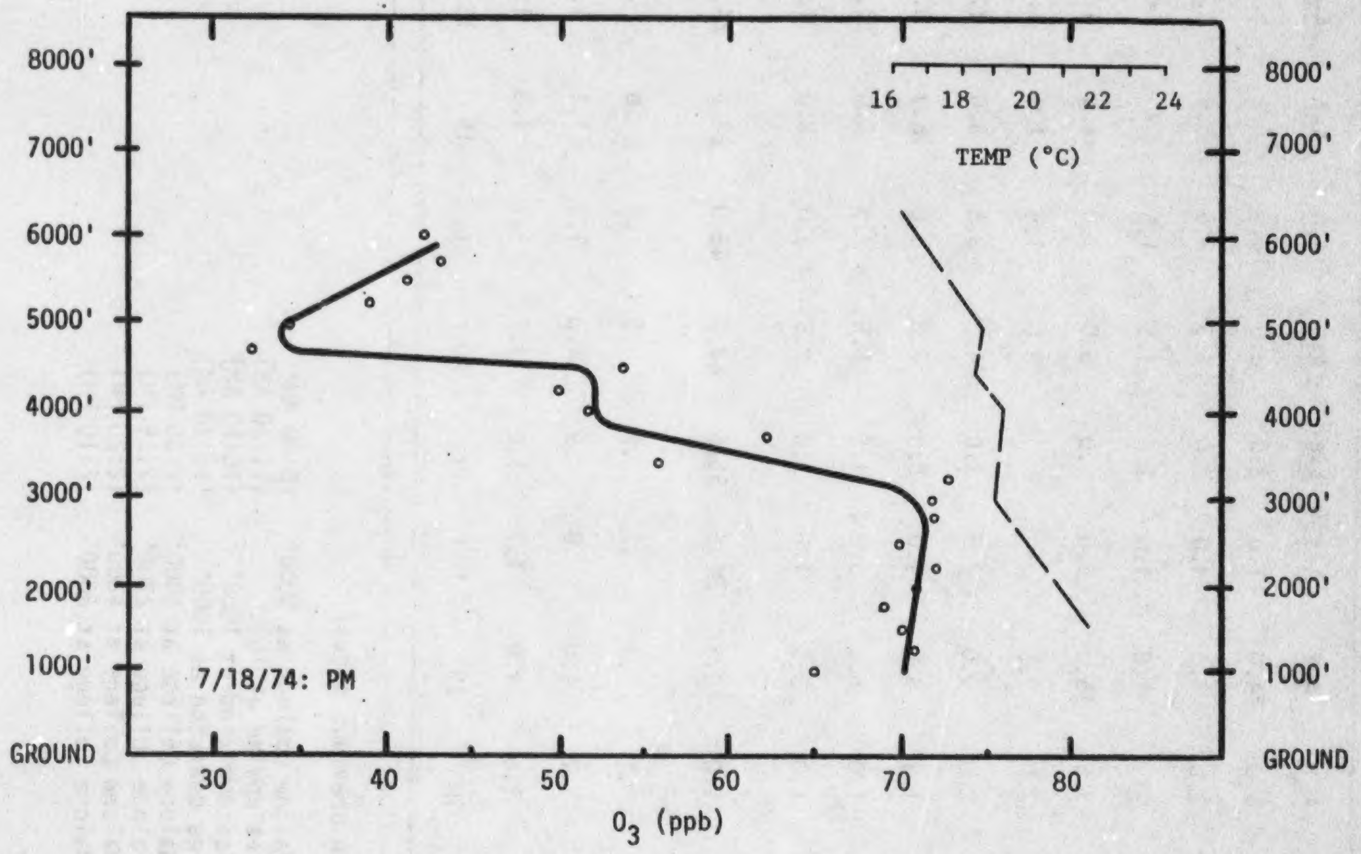


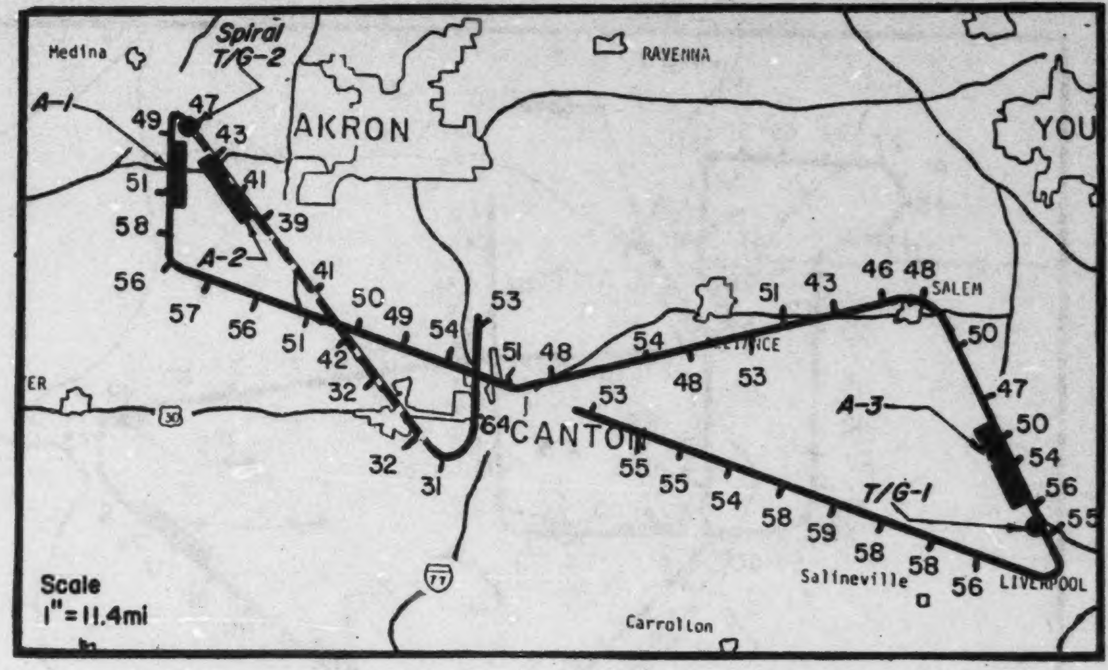
Figure B-58. Spiral climb over Malone College (2:30 pm) on July 18, 1974.

TABLE B-15. AIRCRAFT COLLECTED BAG SAMPLES. JULY 18, 1974.

	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8
Ethane	6.0	24.0	11.0	12.0	8.0	10.5	7.0	5.5
Ethylene	2.0	4.5	4.0	2.0	4.5	3.5	2.5	3.0
Acetylene	*	1.0	1.0	1.0	1.5	1.5	*	*
Propane	3.5	15.0	5.0	6.0	6.0	7.0	4.0	4.0
Propene	2.0	2.5	*	*	3.0	1.5	1.0	1.0
i-Butane	2.0	5.0	2.5	3.0	4.0	3.5	3.0	2.0
n-Butane	1.5	8.0	4.0	5.0	7.0	8.0	6.0	5.0
i-Pentane	1.0	5.0	3.5	4.5	6.5	7.5	3.0	2.5
n-Pentane	1.0	3.5	1.5	2.0	2.5	3.0	2.0	1.5
Total $\mu g/m^3$	19.0	68.5	32.5	35.5	43.0	46.0	28.5	24.5
NMTHC (ppm)	.1	.3	.2	.2	.5	.8	.8	.3
CO (ppm)	.7	1.0	.8	.9	1.0	1.3	1.1	1.3
CH_4 (ppm)	1.6	1.8	1.7	1.8	1.7	1.7	1.6	1.6
NO_x (ppb)	10	19	17	19	20	21	15	15

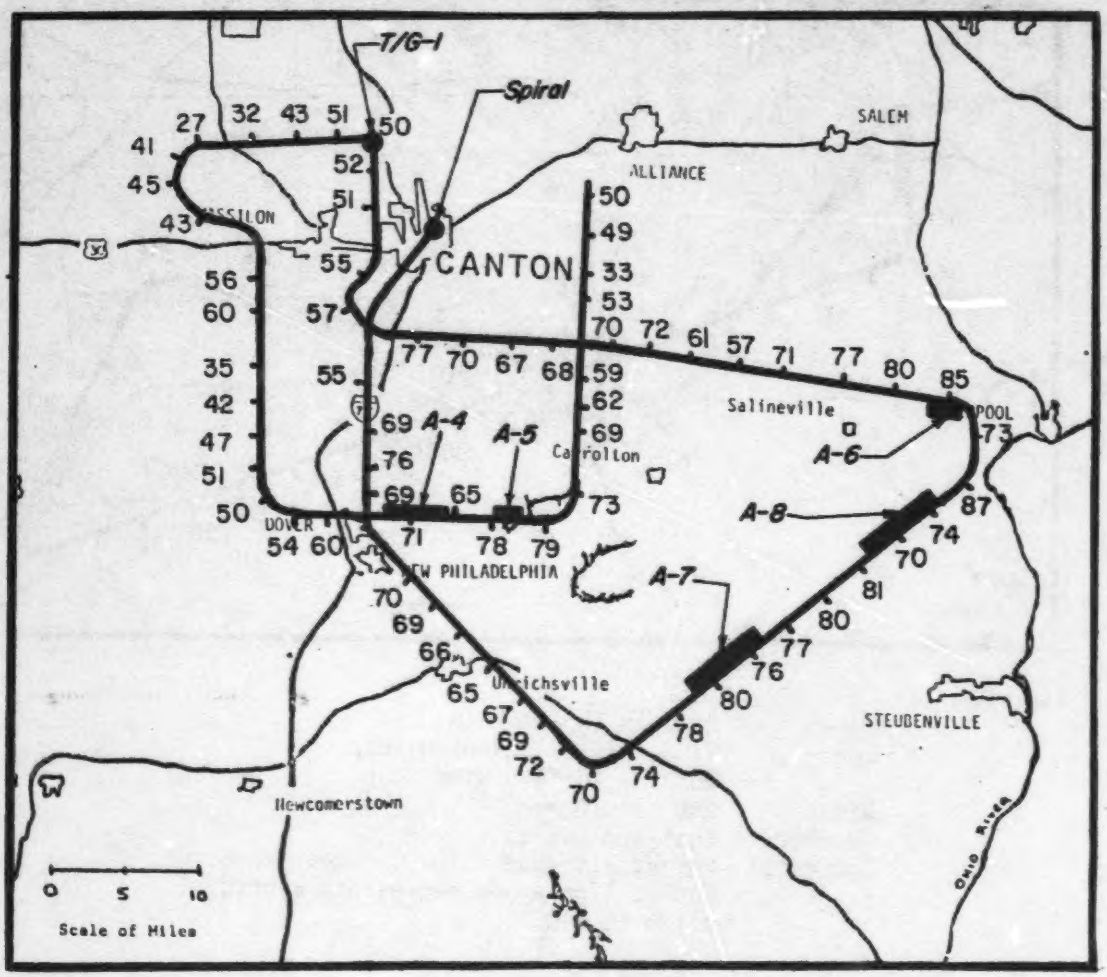
KEY (see map on previous page):

A-1	Over Malone College at 5000'	(9:00 AM)
A-2	28 miles upwind at 1000'	(11:20 AM)
A-3	24 miles downwind at 1000'	(10:50 AM)
A-4	50 miles downwind at 1000'	(10:20 AM)
A-5	Over Malone College at 1000'	(2:30 PM)
A-6	Over Malone College at 2300'	(2:25 PM)
A-7	Over Malone College at 4000'	(2:20 PM)
A-8	Over Malone College at 6000'	(2:10 PM)


Medina
Spiral T/G-2
RAVENNA
AKRON
YOU
A-1
49
47
43
51
41
58
39
A-2
56
41
57
56
50
49
51
54
53
42
32
51
48
54
48
53
51
43
46
48
SALEM
50
47
A-3
50
54
56
55
CANTON
53
64
32
31
55
55
54
58
59
58
58
56
T/G-1
Saltneville
LIVERPOOL
Carrollton
77
30
Scale
1"=11.4mi

Time: 9:00 am to 10:50 am
Leg: 9:03 - 10:02 Downwind loop
10:02 - 10:48 Upwind loop
Wind: 290° at 10 mph
Weather: Cool and overcast
Comments: Flight altitude - 1000' except dashed line which represents a gradual climb to 5700'.

Figure B-59. Morning flight path on July 19, 1974.


T/G-1
Spiral
SALEM
ALLIANCE
MASSILLON
CANTON
Salineville
POOL
Carrollton
DOVER
NEW PHILADELPHIA
Uhrichsville
STEUBENVILLE
Newcomerstown
OHIO RIVER
A-4
A-5
A-6
A-7
A-8
0 5 10
Scale of Miles

Time: 1:30 pm to 4:00 pm
Leg: 2:03 - 3:05 Long downwind
3:05 - 3:31 Upwind loop
3:31 - 3:58 Short downwind
Wind: 340° at 15 mph
Weather: Mostly sunny; hot and humid
Comments: Flight altitude - 1000'

Figure B-60. Afternoon flight path on July 19, 1974.

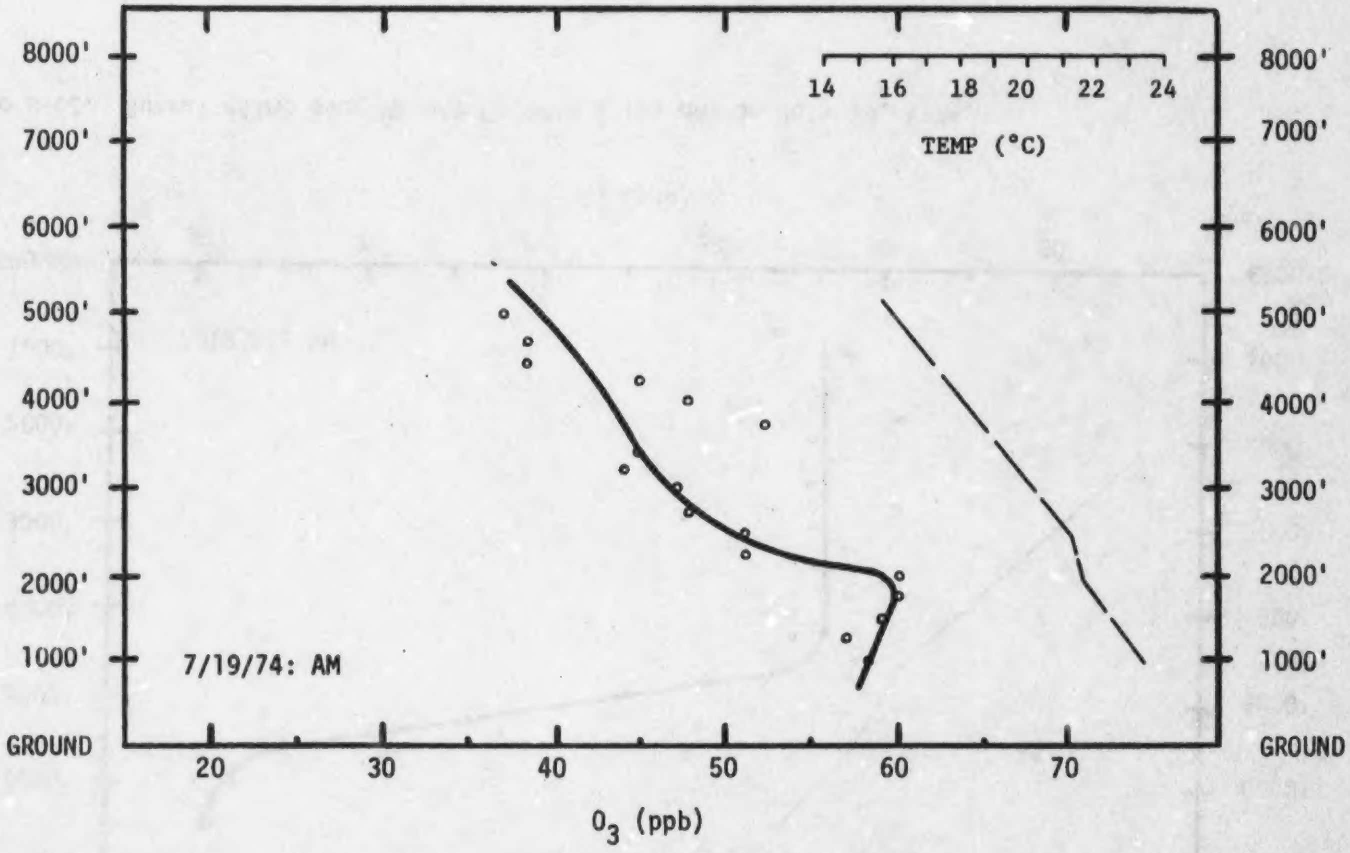


Figure B-61. Spiral climb over Weltzien Airport (10:45 am) on July 19, 1974.

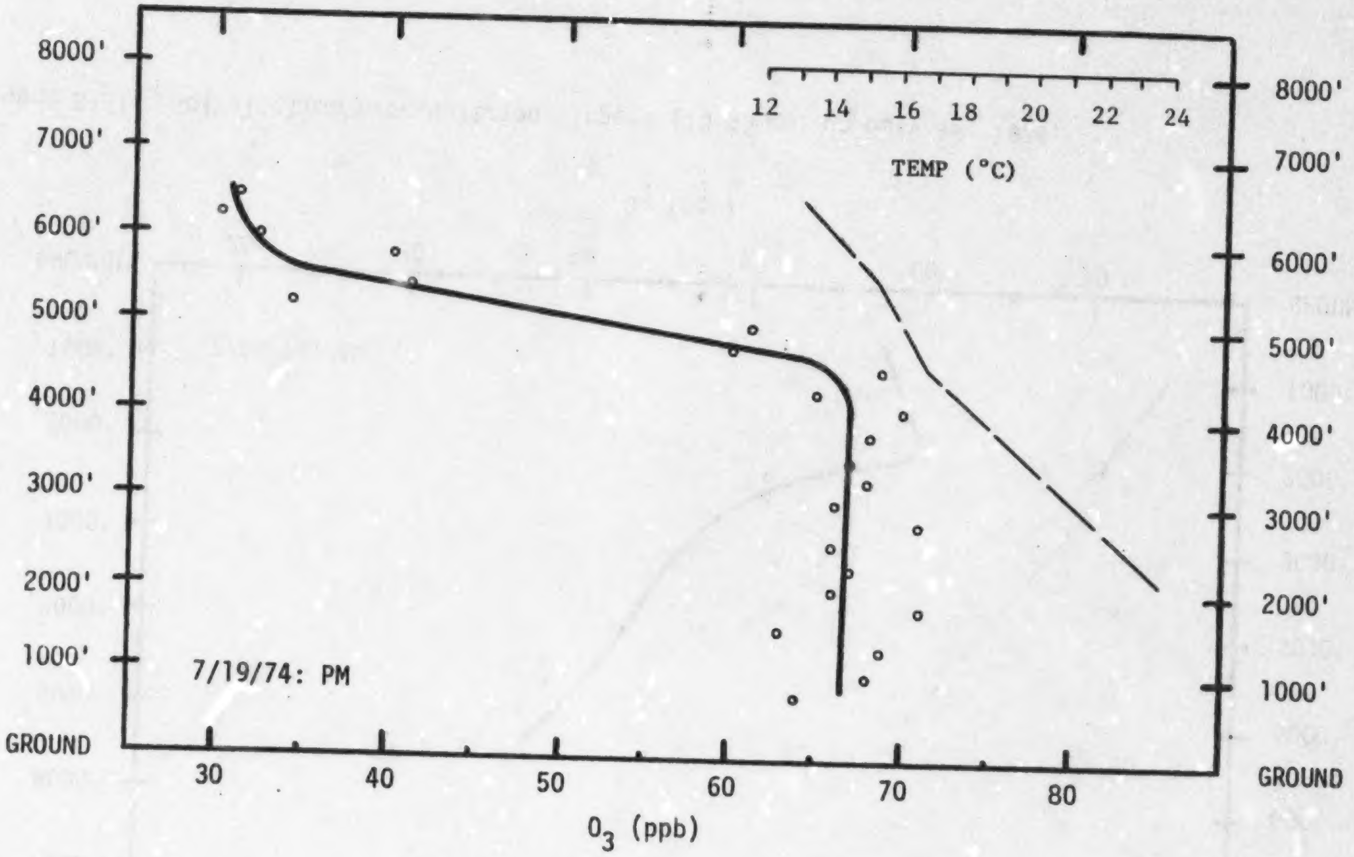


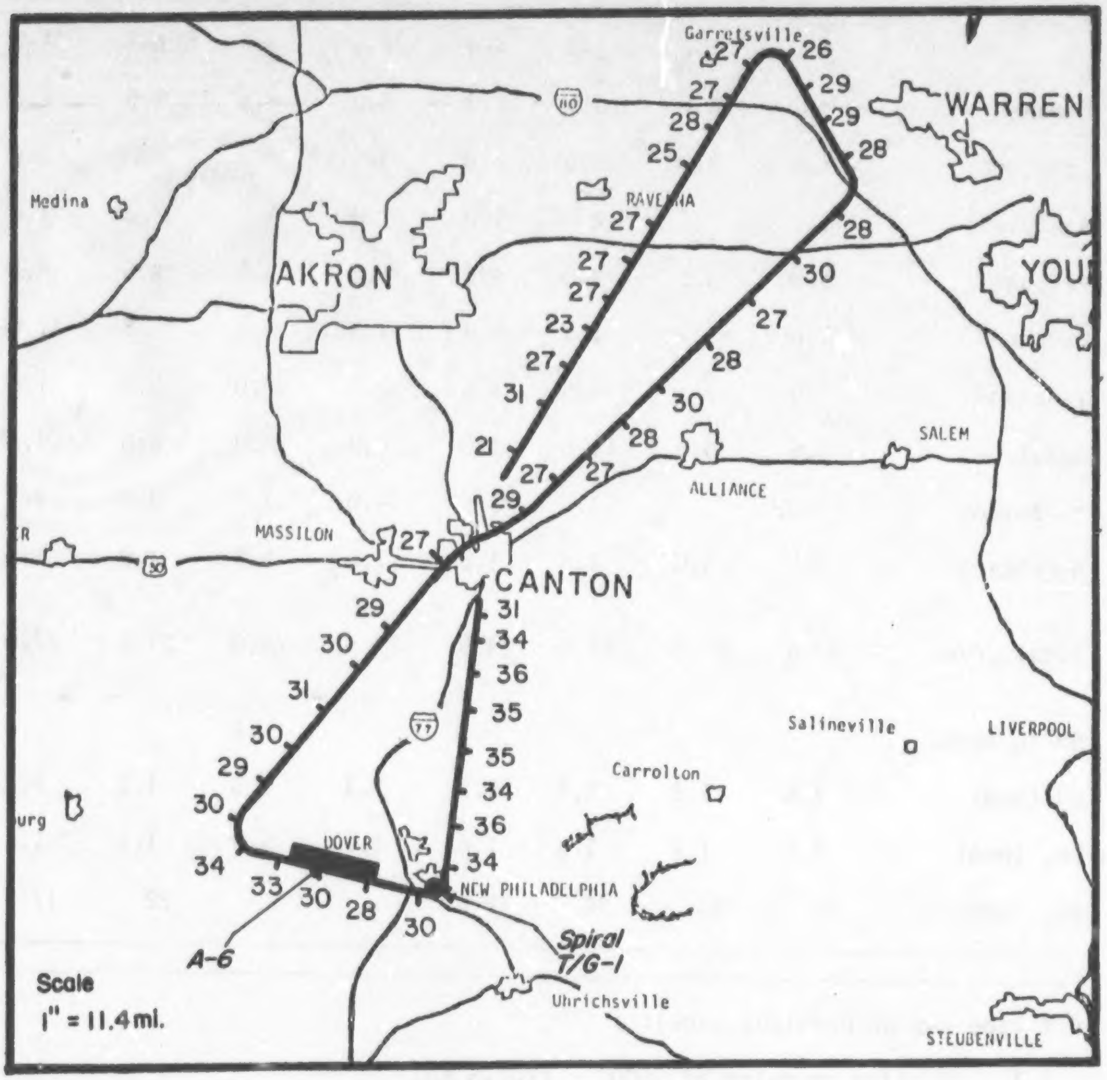
Figure B-62. Spiral climb over Malone College (1:59 pm) on July 19, 1974.

TABLE B-16. AIRCRAFT COLLECTED BAG SAMPLES. JULY 19, 1974.

	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8
Ethane	9.0	6.0	13.5	7.0	8.0	6.5	7.5	7.0
Ethylene	5.0	7.0	5.5	3.0	3.5	2.5	3.0	3.0
Acetylene	1.5	.5	2.0	1.0	1.0	1.0	2.0	1.0
Propane	6.5	3.5	10.0	4.0	5.5	3.5	4.5	4.0
Propene	1.0	.5	1.5	1.0	1.5	1.0	.5	1.0
i-Butane	3.5	2.5	4.5	1.5	2.0	2.0	2.5	1.5
n-Butane	6.5	6.5	11.0	3.0	4.0	3.0	4.0	4.5
i-Pentane	7.0		11.5	2.5	4.0	3.0	3.5	3.5
n-Pentane	2.5	5.0	4.5	1.5	1.5	1.5	2.0	1.5
Total $\mu g/m^3$	42.5	31.5	64.0	24.5	29.5	24.0	29.5	27.0
NMTHC (ppm)				.3		.4		.3
CO (ppm)	1.4	1.2	1.4	1.2	1.3	1.5	1.3	1.2
CH_4 (ppm)	1.7	1.7	1.8	1.6	1.7	1.7	1.7	1.6
NO_x (ppb)	29	30	34	18			22	17

KEY (see map on previous page):

A-1	20 miles downwind at 1000'	(10:15 AM)
A-2	20 miles downwind at 3400'	(10:30 AM)
A-3	34 miles downwind at 1000'	(9:35 AM)
A-4	18 miles downwind at 1000'	(3:40 PM)
A-5	18 miles downwind at 1000'	(3:45 PM)
A-6	36 miles downwind at 1000'	(2:45 PM)
A-7	36 miles downwind at 1000'	(2:30 PM)
A-8	40 miles downwind at 1000'	(2:35 PM)


Garretsville
27
26
27
29
WARREN
28
29
25
28
Medina
RAVENNA
27
28
AKRON
27
30
YOU
27
23
27
27
28
31
30
SALEM
21
28
27
27
ALLIANCE
29
MASSILON
27
CANTON
29
31
30
34
36
31
35
30
Salineville
LIVERPOOL
29
35
Carrolton
30
34
urg
36
DOVER
34
34
33
30
NEW PHILADELPHIA
28
30
Spiral T/G-1
A-6
Scale
1" = 11.4 mi.
Uhrichsville
STEUBENVILLE

Time: 9:25 am to 11:35 am
Leg: 9:45 - 10:30 Upwind loop
10:30 - 11:35 Downwind loop
Wind: 030° at 9 mph
Weather: Sunny and cool
Comments: Flight altitude = 1000'

Figure B-63. Morning flight path on July 20, 1974.

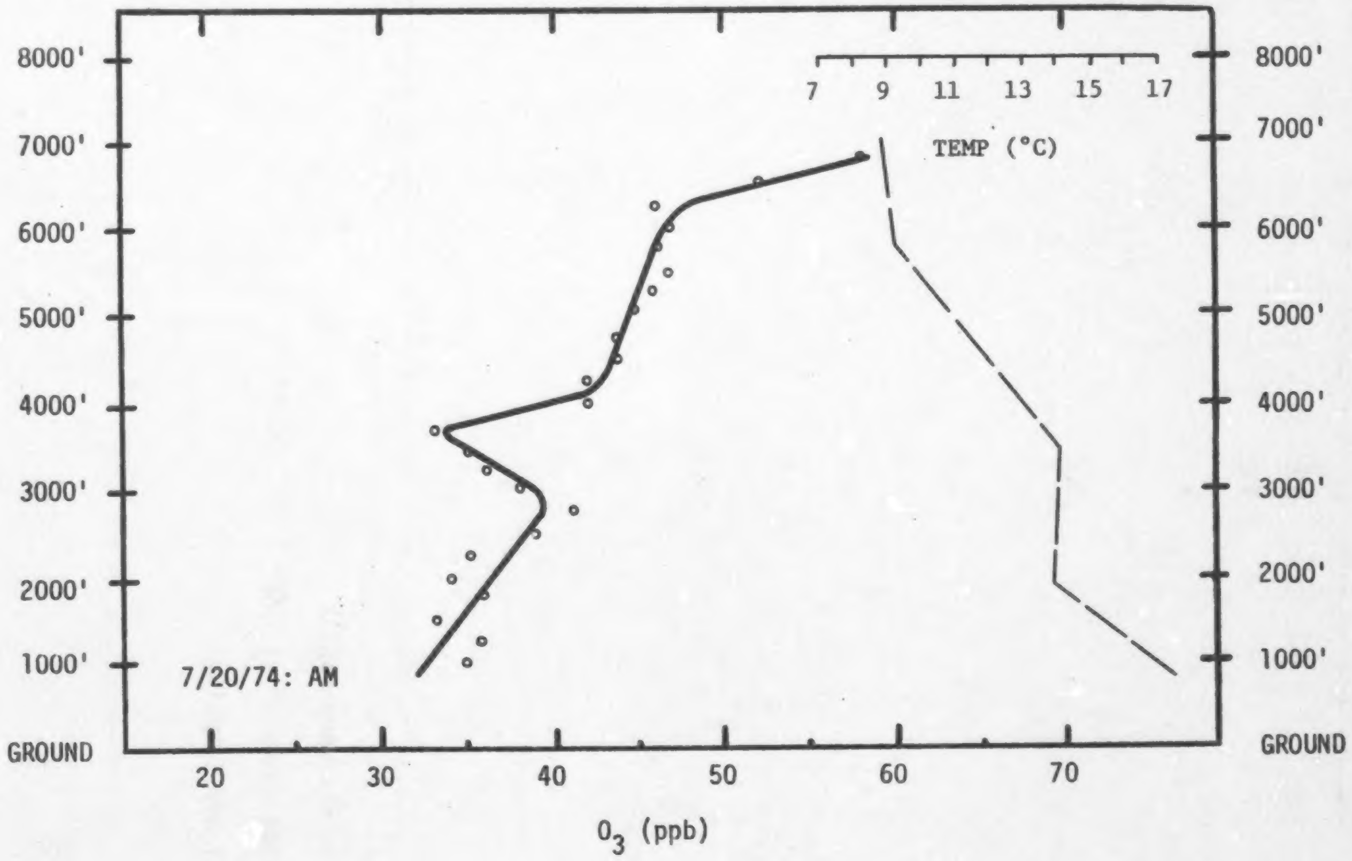


Figure B-64. Spiral climb over Dover (11:21 am) on July 20, 1974.

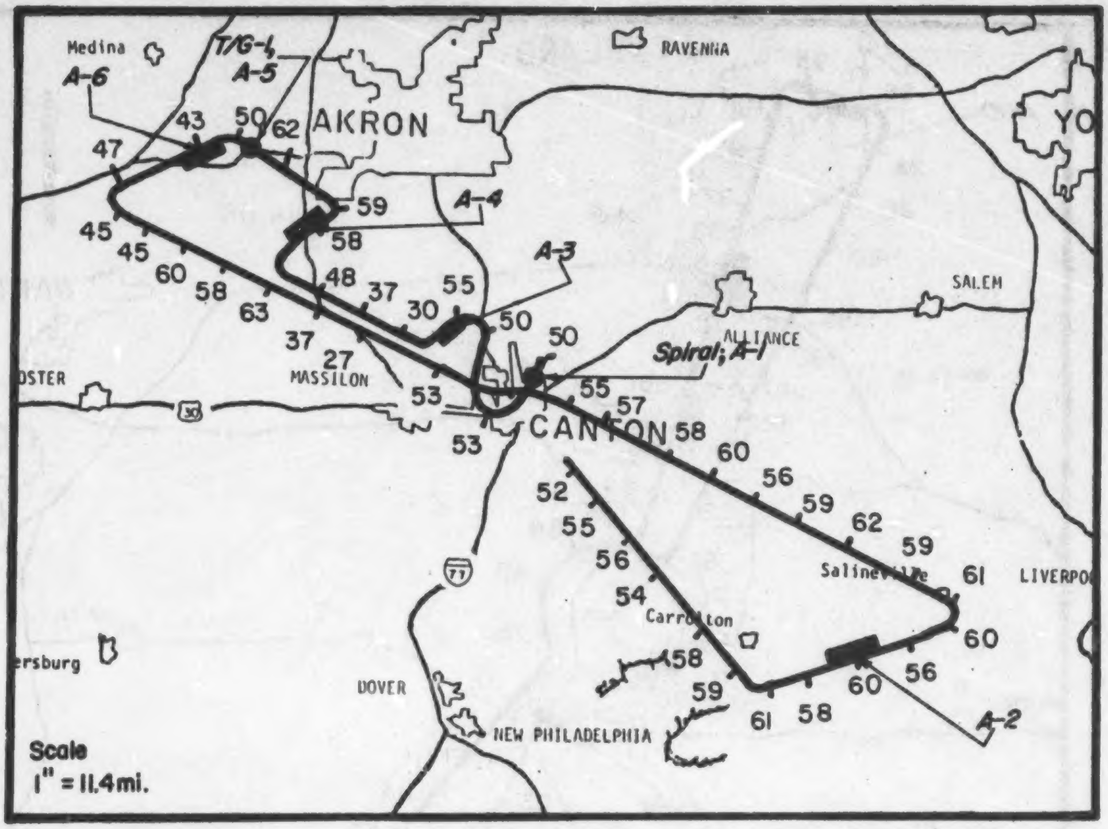
TABLE B-17. AIRCRAFT COLLECTED BAG SAMPLES. JULY 20, 1974.

	A-6
Ethane	9.0
Ethylene	5.0
Acetylene	1.0
Propane	5.0
Propene	1.5
i-Butane	3.5
n-Butane	7.0
i-Pentane	8.5
n-Pentane	4.0
Total $\mu g/m^3$	44.5
NMTHC (ppm)	.2
CO (ppm)	.9
CH_4 (ppm)	1.7
NO_x (ppb)	17

KEY (see map on previous page):

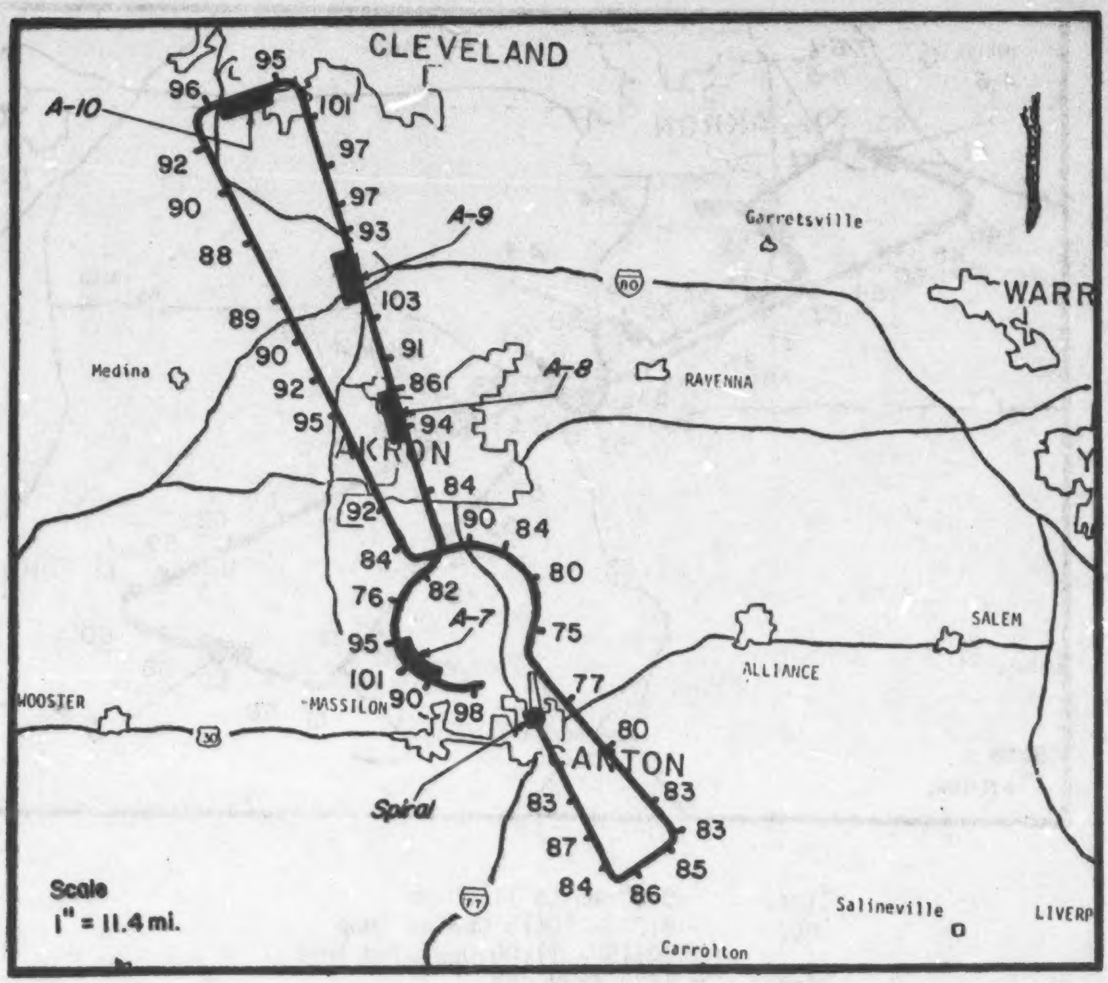
A-6 20 miles downwind at 1000' (10:45 AM)

A-1-5 Refinery Sampling


Medina
A-6
T/G-1,
A-5
RAVENNA
AKRON
YO
43
50
62
47
59
A-4
45
45
58
60
58
48
37
55
A-3
63
30
50
37
27
50
SALEM
ALLIANCE
Spiral; A-1
OSTER
MASSILON
53
55
57
53
CANTON
58
60
56
52
59
55
62
59
56
Salineville
61
LIVERPO
54
Carrollton
60
ersburg
58
56
59
60
DOVER
61
58
A-2
NEW PHILADELPHIA
Scale
1" = 11.4mi.

Time:	9:00 am to 11:00 am
Leg:	9:27 - 10:15 Upwind loop 10:15 - 11:00 Downwind loop
Wind:	150° at 2 mph
Weather:	Scattered clouds and light haze
Comments:	Flight altitude = 1000'

Figure B-65. Morning flight path on July 22, 1974.


CLEVELAND
95
96
101
A-10
97
92
97
90
A-9
93
Garretsville
88
103
WARR
89
91
90
Medina
86
A-8
RAVENNA
92
95
94
AKRON
84
92
90
84
84
80
82
76
A-7
75
95
SALEM
77
ALLIANCE
101
90
WOOSTER
MASSILON
98
30
80
CANTON
83
83
Spiral
83
87
85
84
86
77
Scale
1" = 11.4 mi.
Salineville
LIVERP
Carrolton

Time: 7:35 pm to 9:10 pm
Leg: 8:00 - 8:16 Upwind loop
8:16 - 9:08 Downwind loop
Wind: 170° at 5 mph
Weather: Overcast and hazy
Comments: Flight altitude = 1000'

Figure B-66. Night flight path on July 22, 1974.

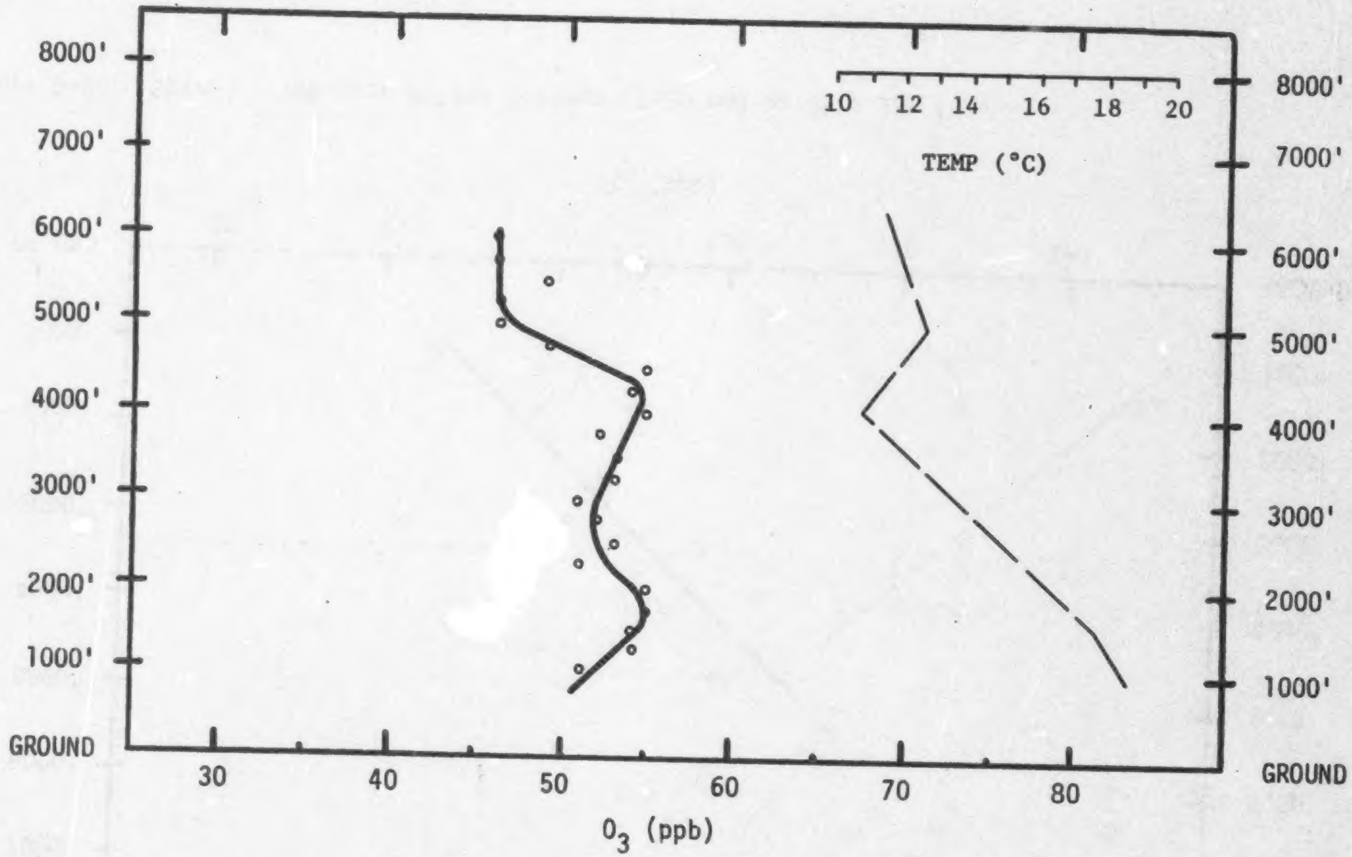


Figure B-67. Spiral climb over Malone College (9:29 am) on July 22, 1974.

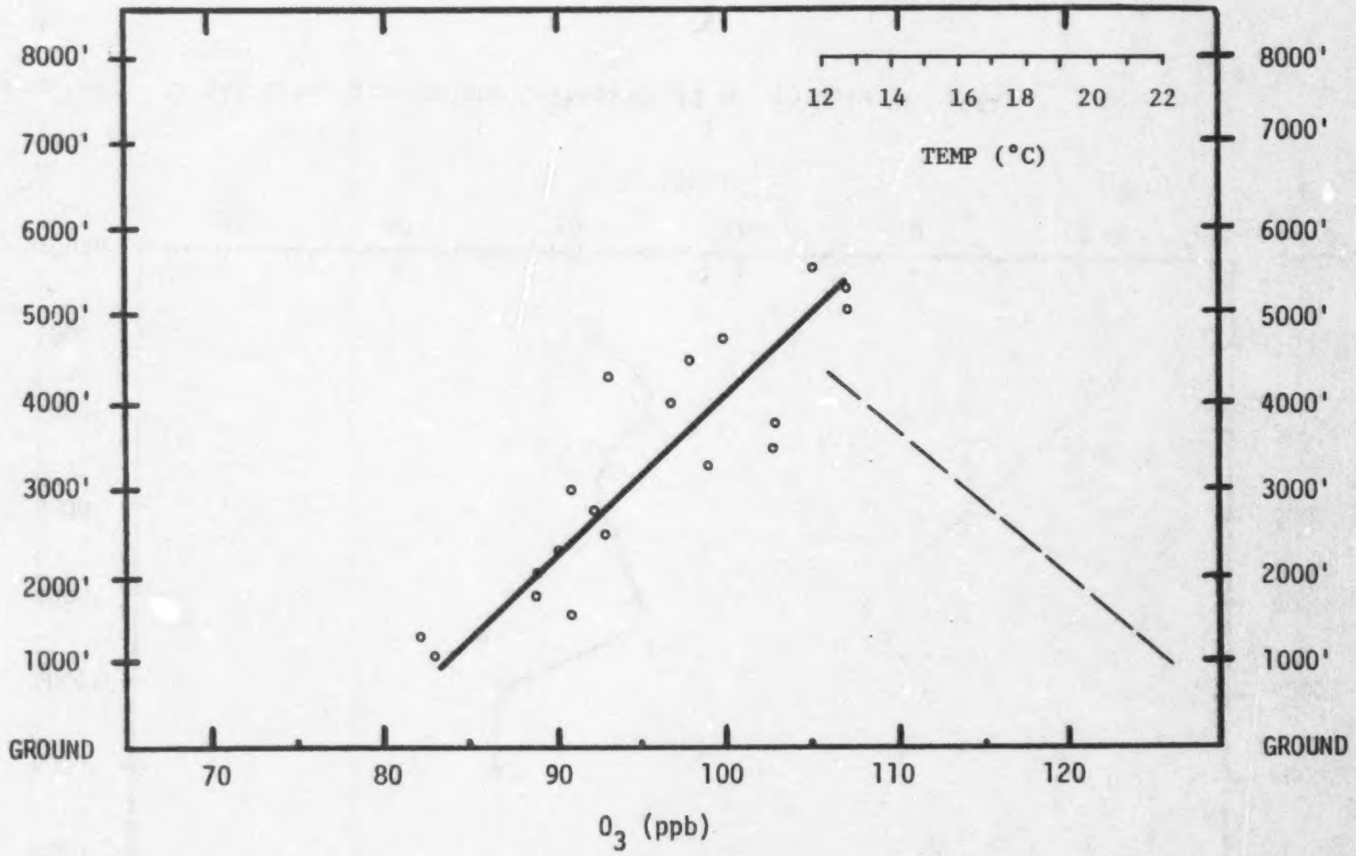


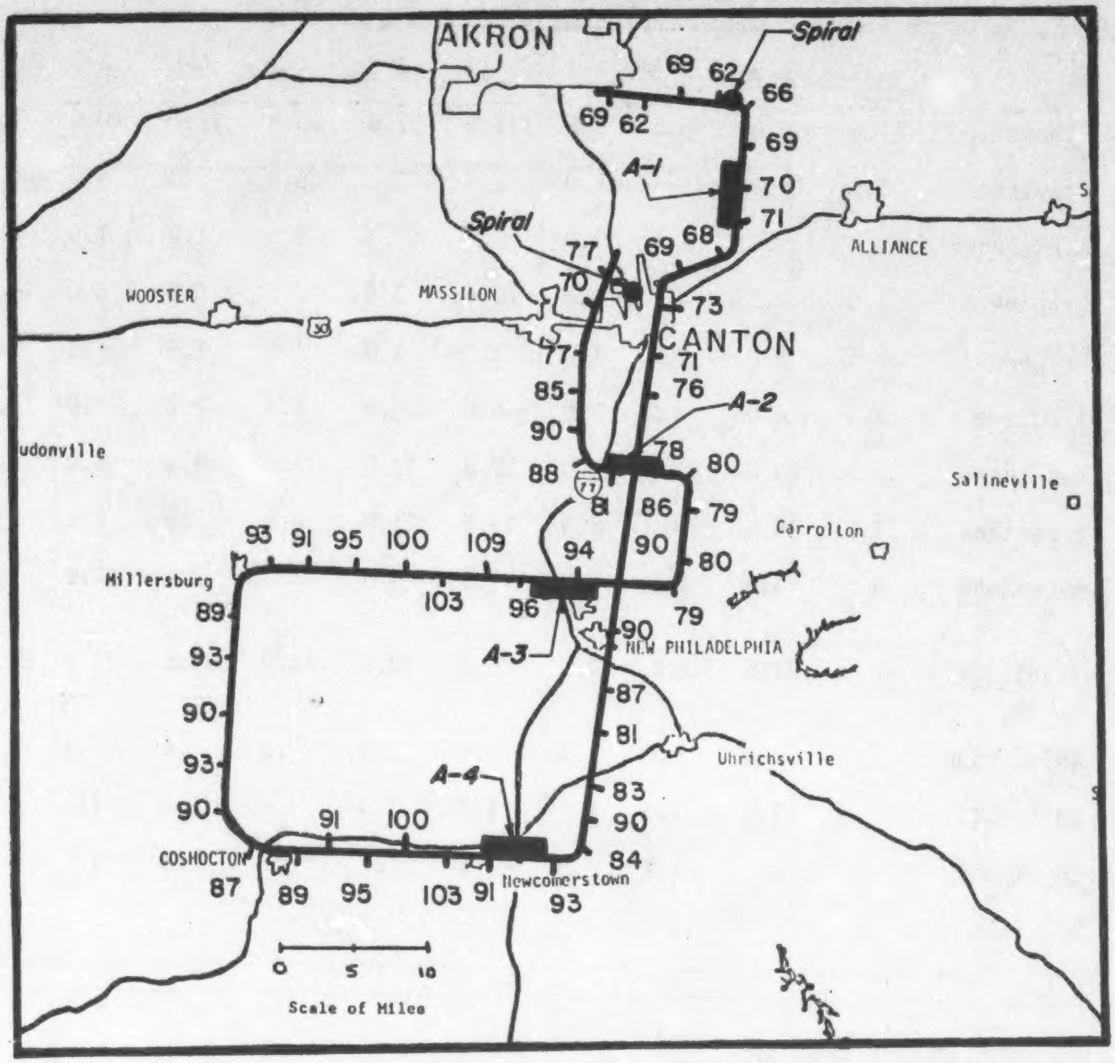
Figure B-68. Spiral climb over Malone College (7:59 pm) on July 22, 1974.

TABLE B-18. AIRCRAFT COLLECTED BAG SAMPLES. JULY 22, 1974.

	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10
Ethane	11.0	6.0	8.5	6.5	21.0	7.5	10.5	12.0	10.0	7.0
Ethylene	6.5	4.0	19.5	5.0	6.0	3.5	5.0	5.0	4.0	4.0
Acetylene	1.0	.5	1.5	1.0	3.0	1.0	2.5	1.0	1.5	4.0
Propane	7.5	2.5	4.5	3.0	10.5	3.5	6.0	5.5	5.0	4.5
Propene	2.5	2.0	2.0	1.0	2.0	1.0	1.0	1.5	.5	.5
i-Butane	8.5	4.0	8.0	2.0	5.0	5.0	2.5	2.0	2.0	1.0
n-Butane	21.0	10.0	21.0	5.0	12.0	12.0	7.0	4.0	5.0	2.5
i-Pentane	37.5	19.0	38.0	8.5	13.0	21.0	6.5	3.5	4.5	2.0
n-Pentane	6.5	3.5	6.0	2.0	5.5	4.0	3.0	2.0	2.0	1.5
Total $\mu g/m^3$	102	51.5	109	34.0	78.0	58.5	44.0	36.5	34.5	27.0
NMTHC (ppm)		.2	.8	.2	.4	.3	.3	.4	.4	.3
CO (ppm)		1.1	1.1	1.1	1.7	1.3	.9	1.0	1.1	.9
CH_4 (ppm)		1.8	1.7	1.6	2.1	1.7	1.7	1.6	1.7	1.6
NO_x (ppb)			17	30						

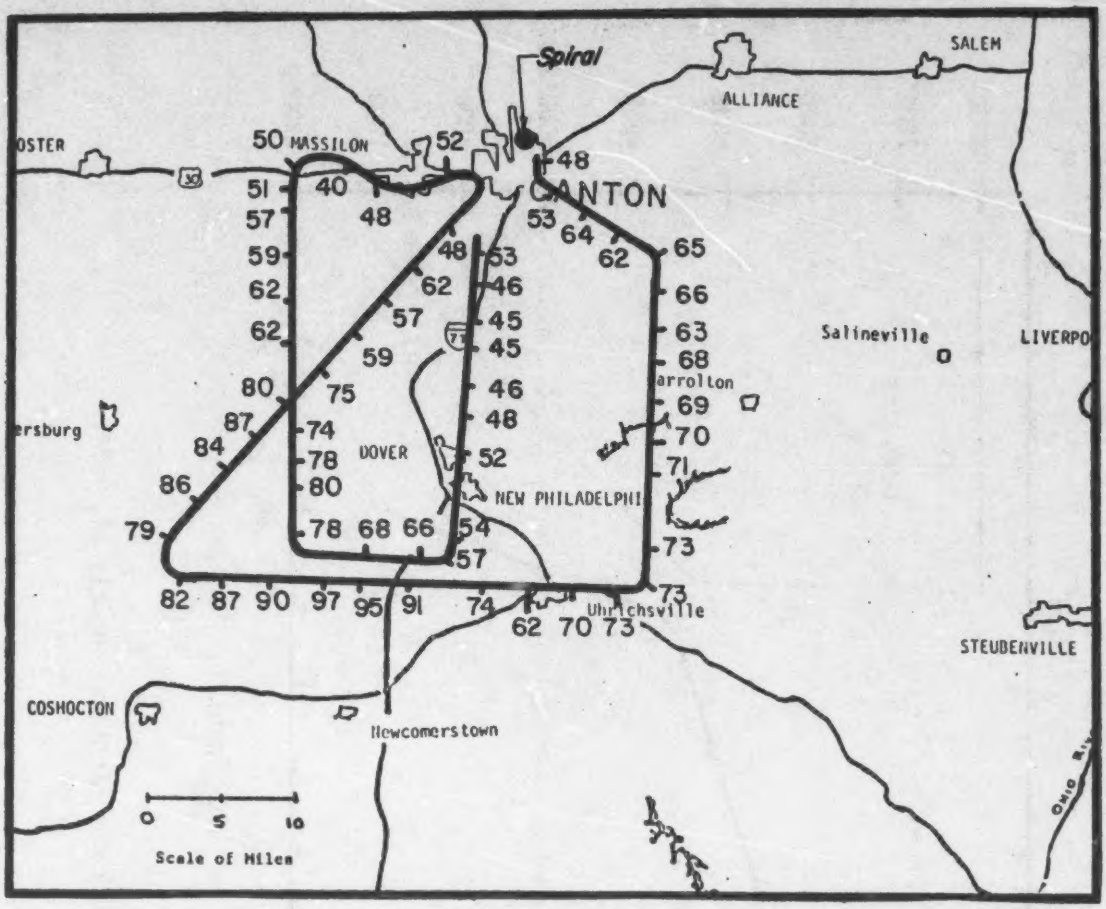
KEY (see map on previous page):

A-1	Over Malone College at 1000'	(10:55 AM)
A-2	30 miles upwind at 1000'	(9:55 AM)
A-3	5 miles downwind at 1000'	(10:50 AM)
A-4	10 miles downwind at 1000'	(10:45 AM)
A-5	25 miles downwind, touch and go	(10:35 AM)
A-6	25 miles downwind at 1000'	(10:30 AM)
A-7	7 miles downwind at 1000'	(9:00 PM)
A-8	20 miles downwind at 1000'	(8:55 PM)
A-9	30 miles downwind at 1000'	(8:45 PM)
A-10	42 miles downwind at 800'	(8:40 PM)


AKRON
Spiral
69
62
66
69
62
69
A-1
70
71
Spiral
77
69
68
ALLIANCE
WOOSTER
MASSILON
30
70
73
CANTON
77
71
85
76
A-2
90
udonville
78
80
88
77
81
86
79
Salineville
Carrolton
93
91
95
100
109
94
90
80
Millersburg
89
103
96
79
90
NEW PHILADELPHIA
A-3
93
87
90
81
Uhrichsville
93
A-4
83
90
91
100
90
COSHOCTON
84
87
89
95
103
91
Newcomerstown
93
0
5
10
Scale of Miles

Time: 2:00 pm to 4:05 pm
Leg: 2:20 - 3:08 Western leg
3:08 - 4:05 Eastern leg
Wind: 360° at 4 mph
Weather: Partly cloudy and warm
Comments: Flight altitude = 1000'

Figure B-69. Afternoon flight path on July 24, 1974.



Spiral
SALEM
ALLIANCE
OSTER
MASSILON
CANTON
Salineville
LIVERPO
arrolton
ersburg
DOVER
NEW PHILADELPHI
Uhrichsville
STEUBENVILLE
COSHOCTON
Newcomerstown
OHIO Ri
0 5 10
Scale of Miles
50
52
48
51
40
48
57
59
62
62
80
87
84
86
79
48
53
46
45
45
46
48
52
62
57
59
75
74
78
80
78 68 66
54
57
53
64
62
65
66
63
68
69
70
71
73
73
82 87 90 97 95 91 74
62 70 73

Time: 8:00 pm to 9:55 pm
Leg: 8:27 - 9:16 Outside loop
9:16 - 9:56 Inside loop
Wind: 360° at 4 mph
Weather: Clear and warm
Comments: Flight altitude = 1000'

Figure B-70. Night flight path on July 24, 1974.

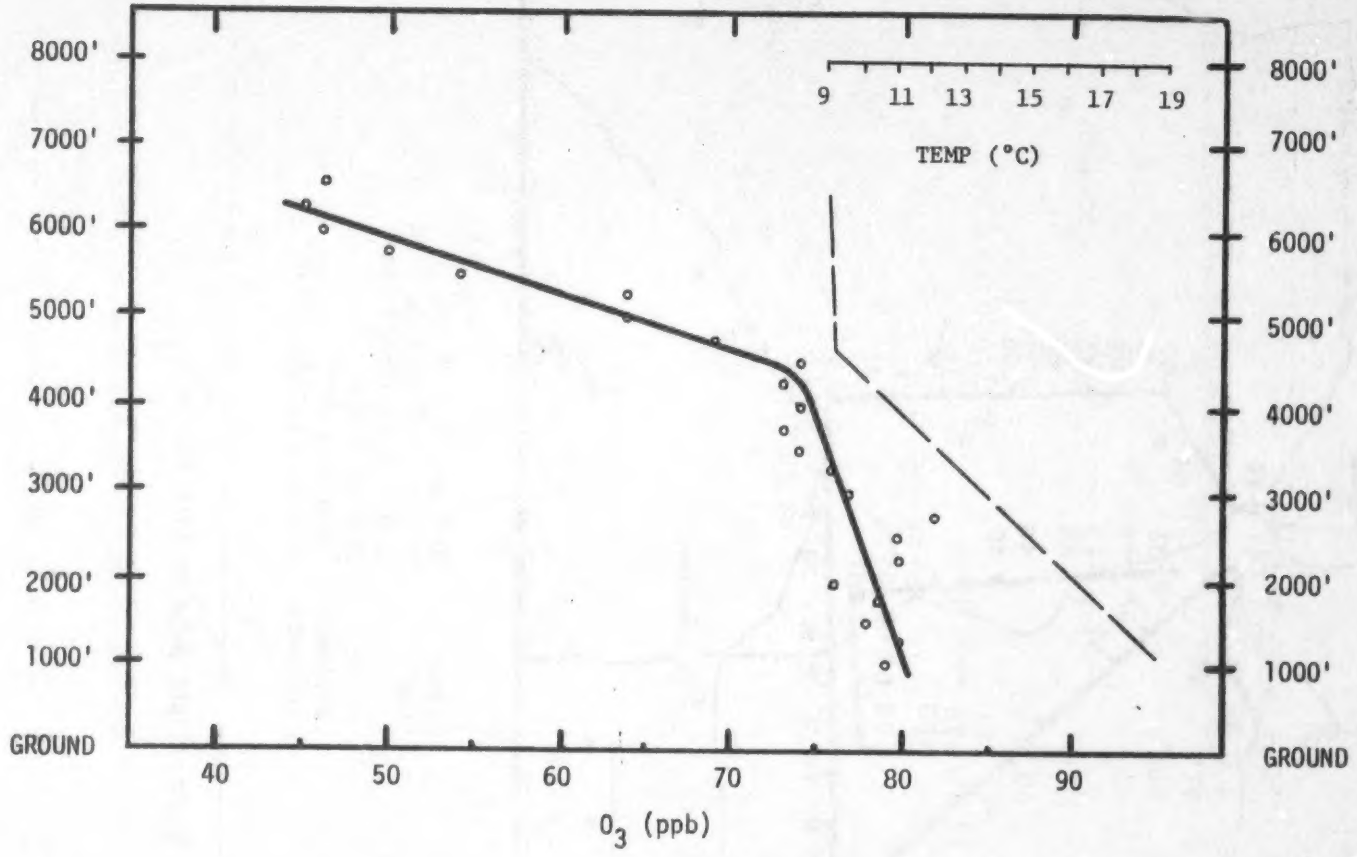


Figure B-71. Spiral climb over Malone College (2:18 pm) on July 24, 1974.

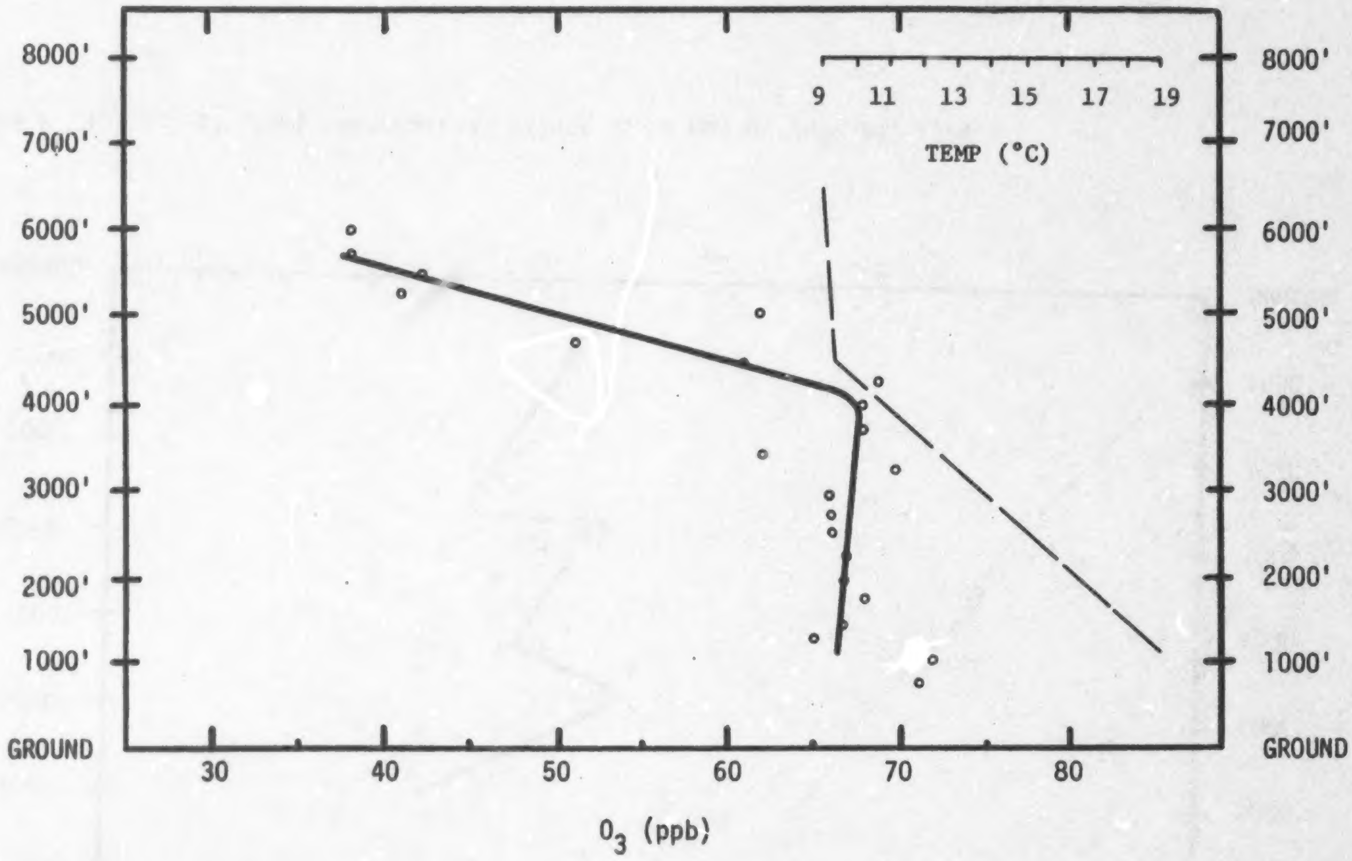


Figure B-72. Spiral climb over Randolph - 15 miles downwind (3:58 pm) on July 24, 1974.

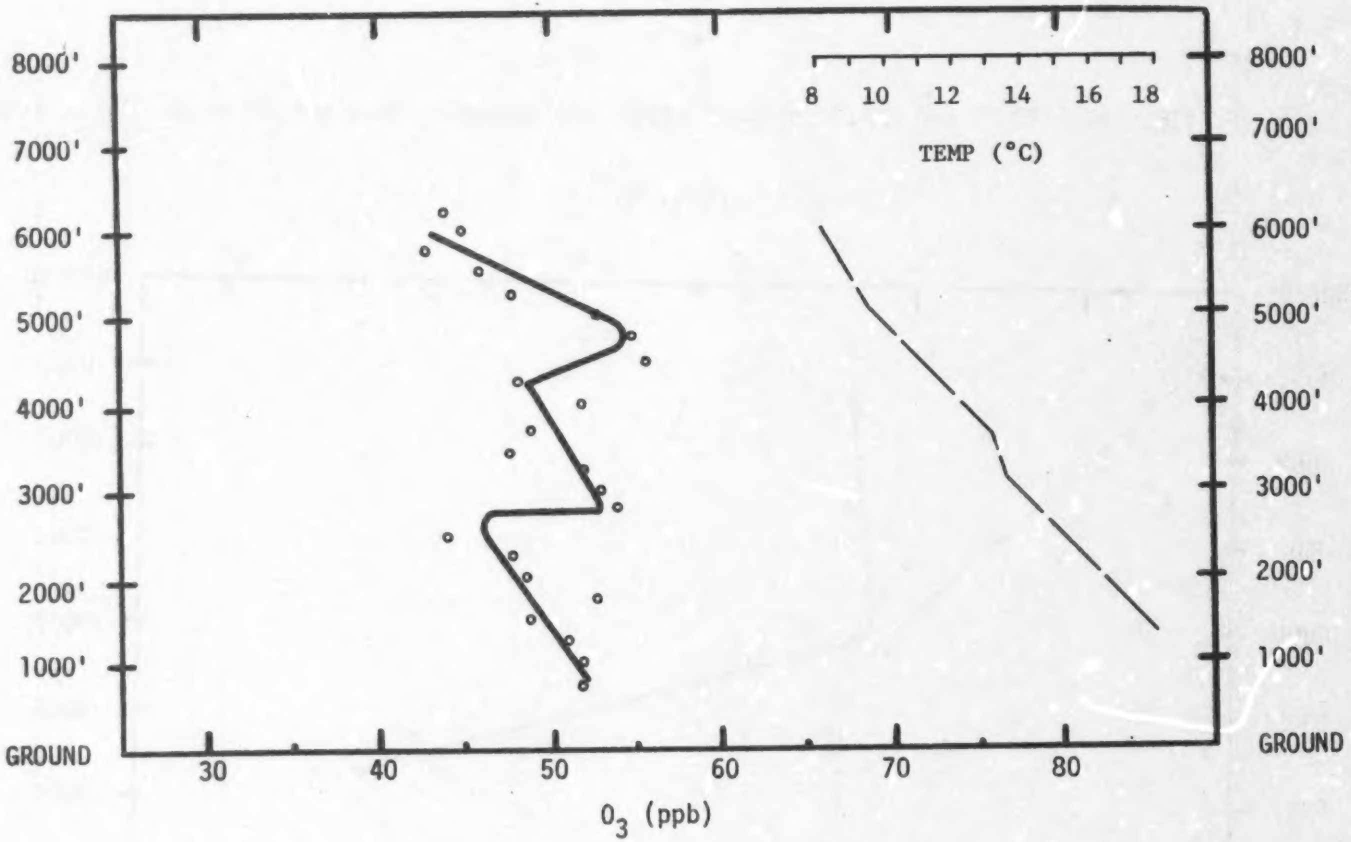


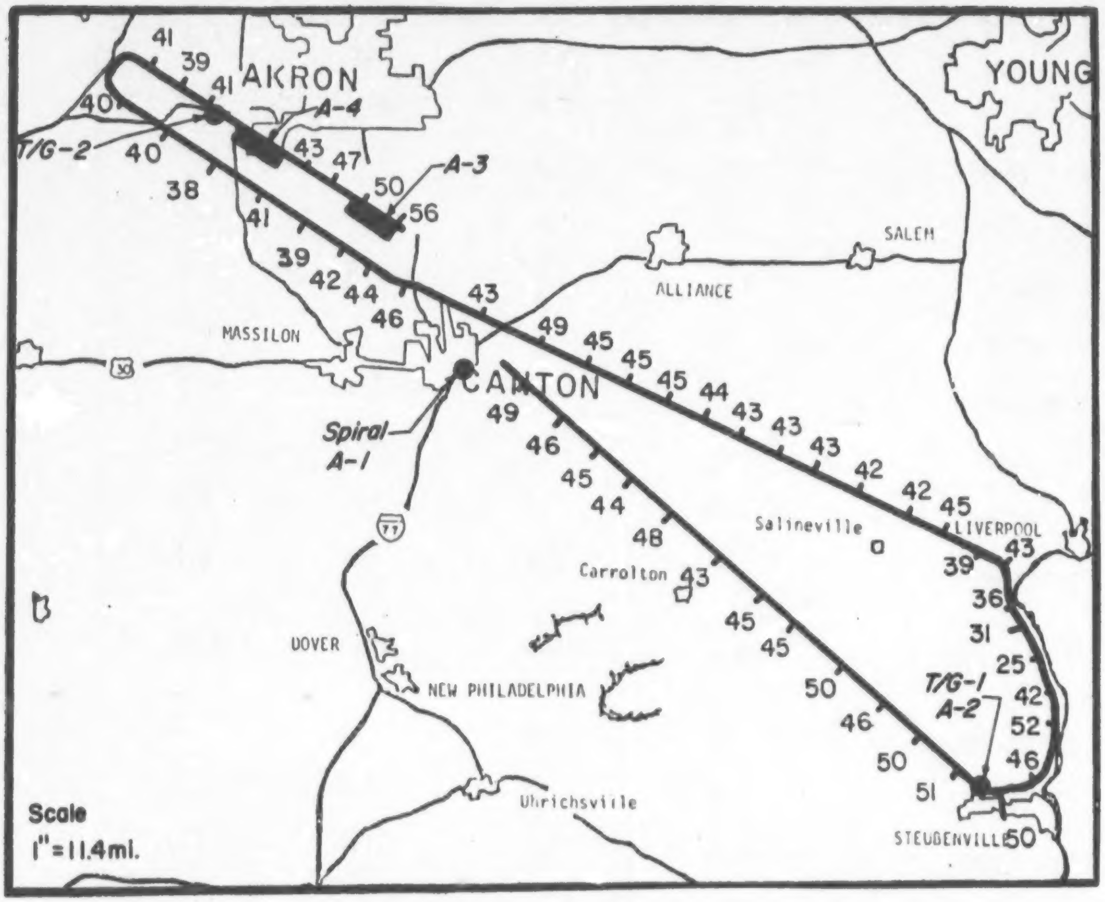
Figure B-73. Spiral climb over Malone College (8:24 pm) on July 24, 1974.

TABLE B-19. AIRCRAFT COLLECTED BAG SAMPLES. JULY 24, 1974.

	A-1	A-2	A-3	A-4
Ethane	6.5	8.0	8.5	9.0
Ethylene	5.0	9.5	5.0	6.0
Acetylene	.5	2.0	2.0	1.5
Propane	3.0	5.0	4.5	5.0
Propene	2.5	1.5	.5	1.0
i-Butane	2.5	3.0	3.5	2.5
n-Butane	2.5	6.5	6.0	5.5
i-Pentane	3.0	7.0	8.0	9.5
n-Pentane	1.0	2.5	2.5	2.5
Total $\mu g/m^3$	26.5	45.0	40.5	42.5
NMTHC (ppm)	.2	.5	.3	.3
CO (ppm)	.9	1.1	1.0	1.0
CH_4 (ppm)	1.6	1.7	1.7	1.6
NO_x (ppb)	17	23	20	19

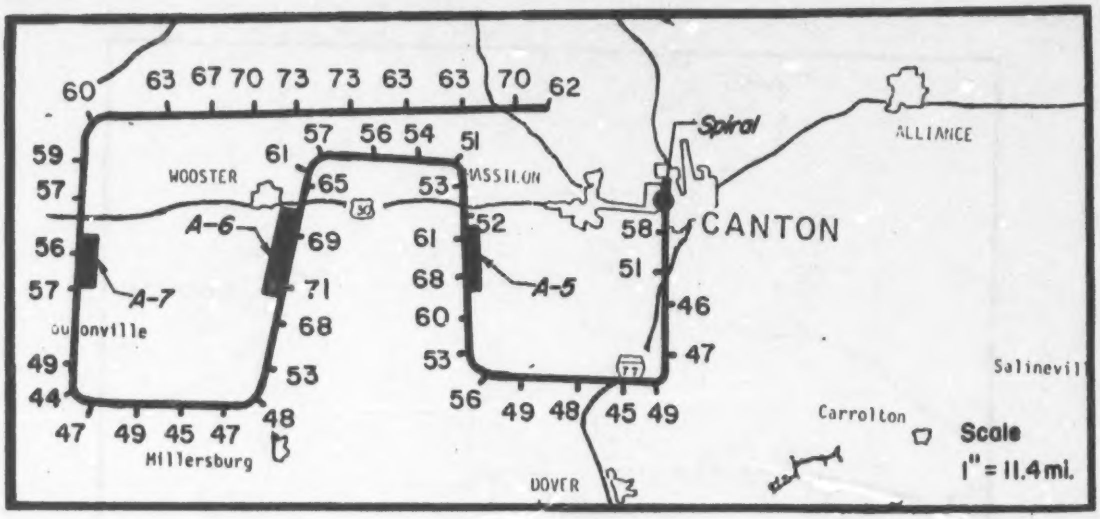
KEY (see map on previous page):

A-1	8 miles upwind at 1000'	(3:35 PM)
A-2	10 miles downwind at 1000'	(2:30 PM)
A-3	20 miles downwind at 1000'	(2:40 PM)
A-4	35 miles downwind at 1000'	(3:05 PM)


41
39
41
AKRON
40
A-4
T/G-2
40
43
47
38
50
A-3
56
41
39
42
44
46
43
SALEM
ALLIANCE
YOUNG
MASSILON
30
49
45
45
45
44
43
43
43
42
42
45
CANTON
49
Spiral A-1
46
45
44
48
43
77
Salineville
LIVERPOOL
43
39
36
31
25
42
52
46
Carrolton
45
45
50
46
50
51
T/G-1 A-2
DOVER
NEW PHILADELPHIA
Uhrichsville
STEUBENVILLE
50
Scale
1"=11.4mi.

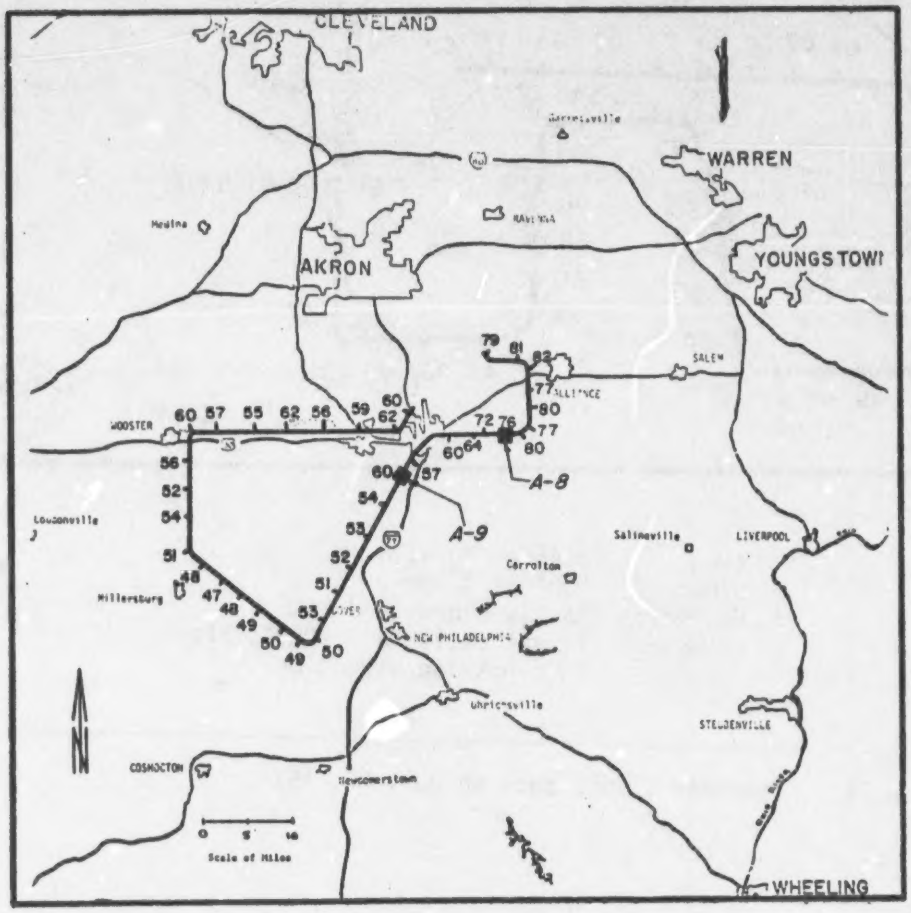
Time: 9:10 am to 11:15 am
Leg: 9:40 - 10:49 Upwind loop
10:49 - 11:15 Downwind loop
Wind: 120° at 3 mph
Weather: Sunny and cool
Comments: Flight altitude = 1000'

Figure B-74. Morning flight path on July 25, 1974.


60
63 67 70 73 73 63 63 70 62
Spiral
ALLIANCE
59
57
57 56 54 51
61
WOOSTER
65
MASSILON
53
A-6
56
69
61
52
58
CANTON
68
A-5
51
57
A-7
71
68
60
46
Orrville
49
53
53
47
44
Salineville
56 49 48 45 49
47 49 45 47 48
Millersburg
Carrolton
Scale
1" = 11.4 mi.
DOVER

Time: 2:45 pm to 4:15 pm
Wind: 080° at 3 mph
Weather: Partly cloudy and hot
Comments: Flight altitude = 1000'; flown in clockwise direction

Figure B-75. Afternoon flight path on July 25, 1974.


CLEVELAND
Garrettsville
WARREN
Medina
Ravenna
AKRON
YOUNGSTOWN
SALEM
ALLIANCE
WOOSTER
Loudonville
Millersburg
Dover
NEW PHILADELPHIA
Carrolton
Salineville
LIVERPOOL
Uhrichsville
STEUBENVILLE
COSHOCTON
Newcomerstown
WHEELING
Ohio River
A-8
A-9
60
57
55
62
56
59
60
62
72
76
79
81
82
77
80
77
80
60
64
60
57
54
53
52
51
53
50
49
50
49
48
47
48
51
54
52
56
N
0
5
10
Scale of Miles

Time: 7:50 pm to 9:00 pm
Wind: 070° at 4 mph
Weather: Cloudy and warm
Comments: Flight altitude = 1000'; flown in counterclockwise direction

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Figure B-76. Night flight path on July 25, 1974.

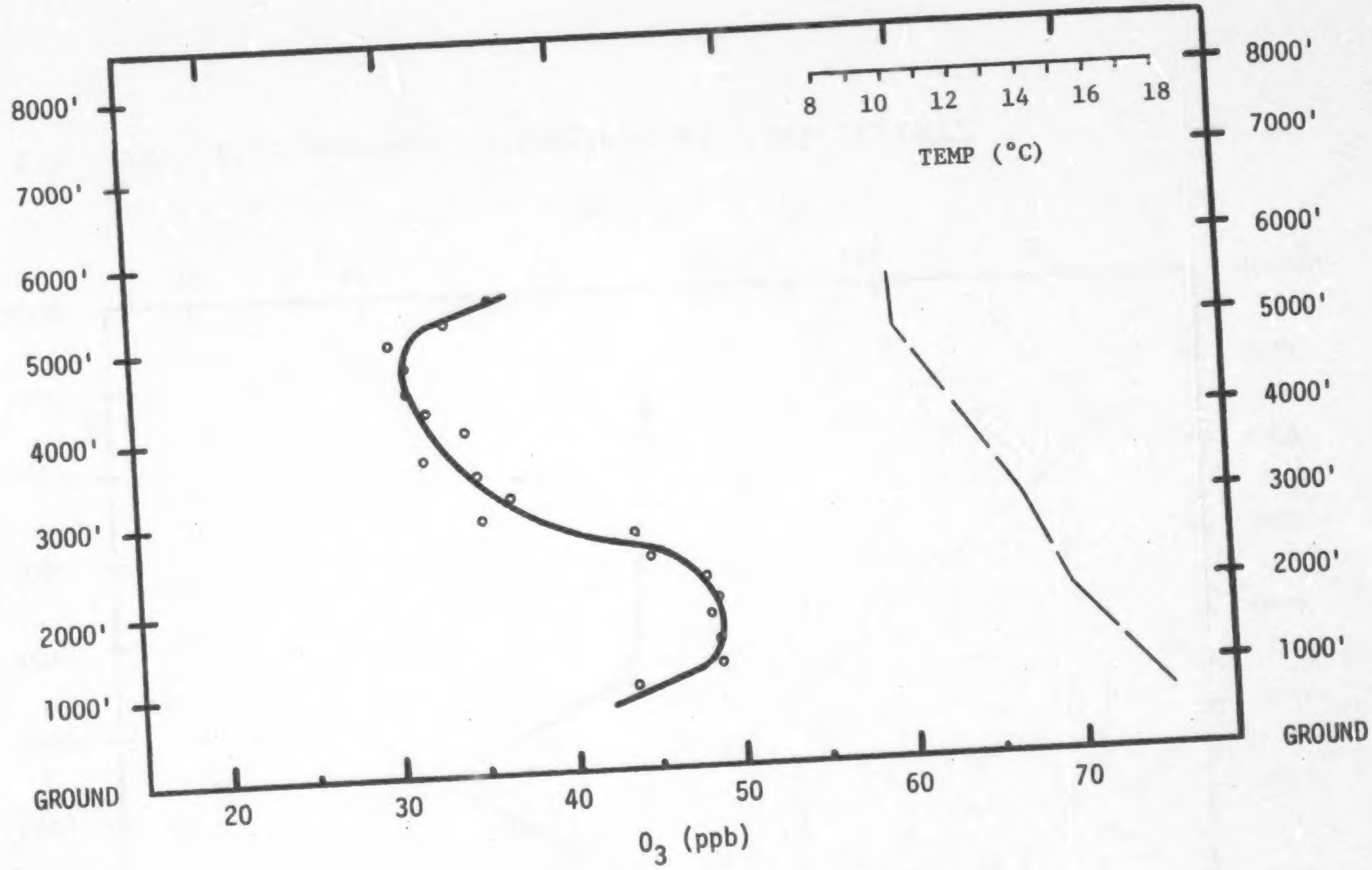

Figure B-77. Spiral climb over Malone College (9:39 am) on July 25, 1974.

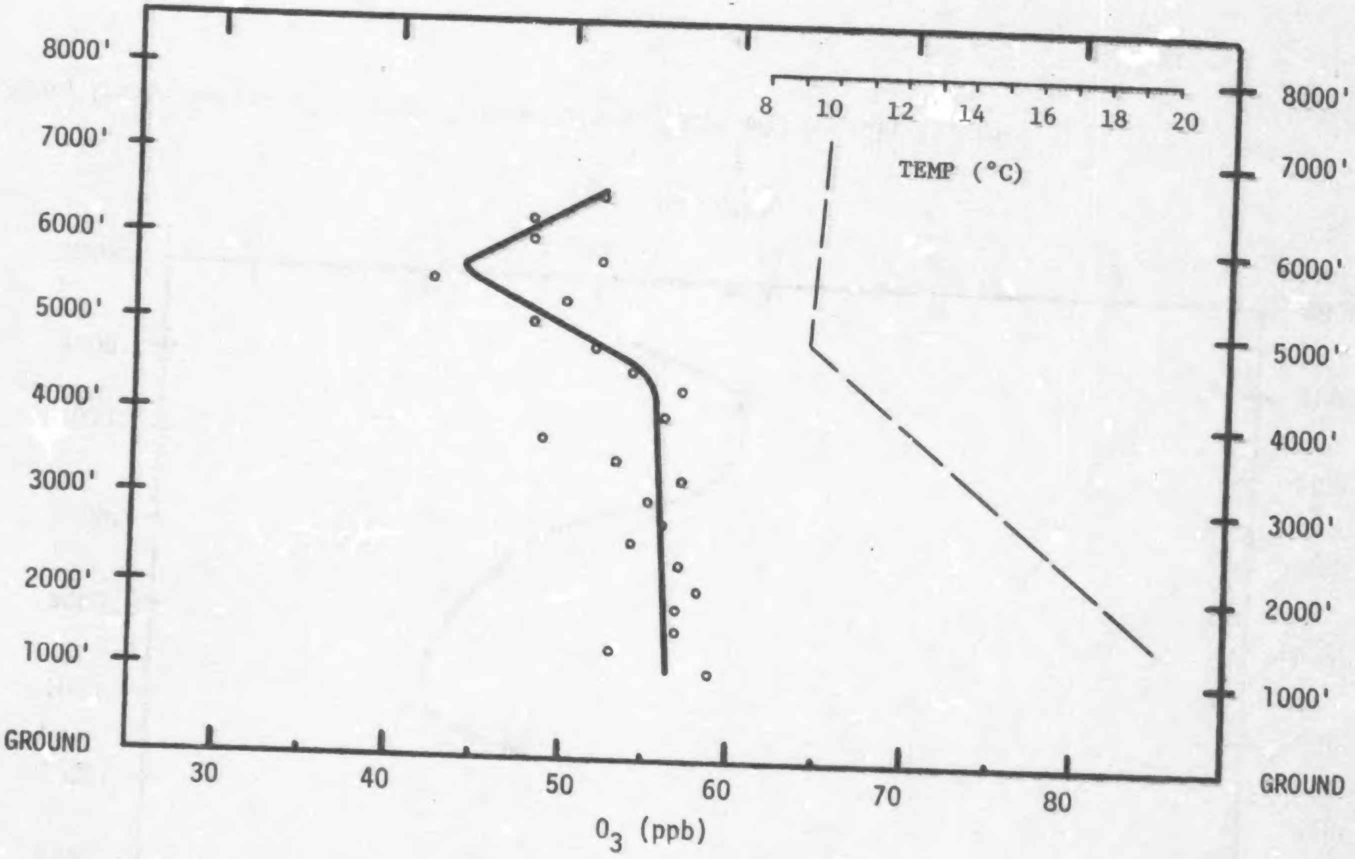

Figure B-78. Spiral climb over Malone College (2:47 pm) on July 25, 1974.

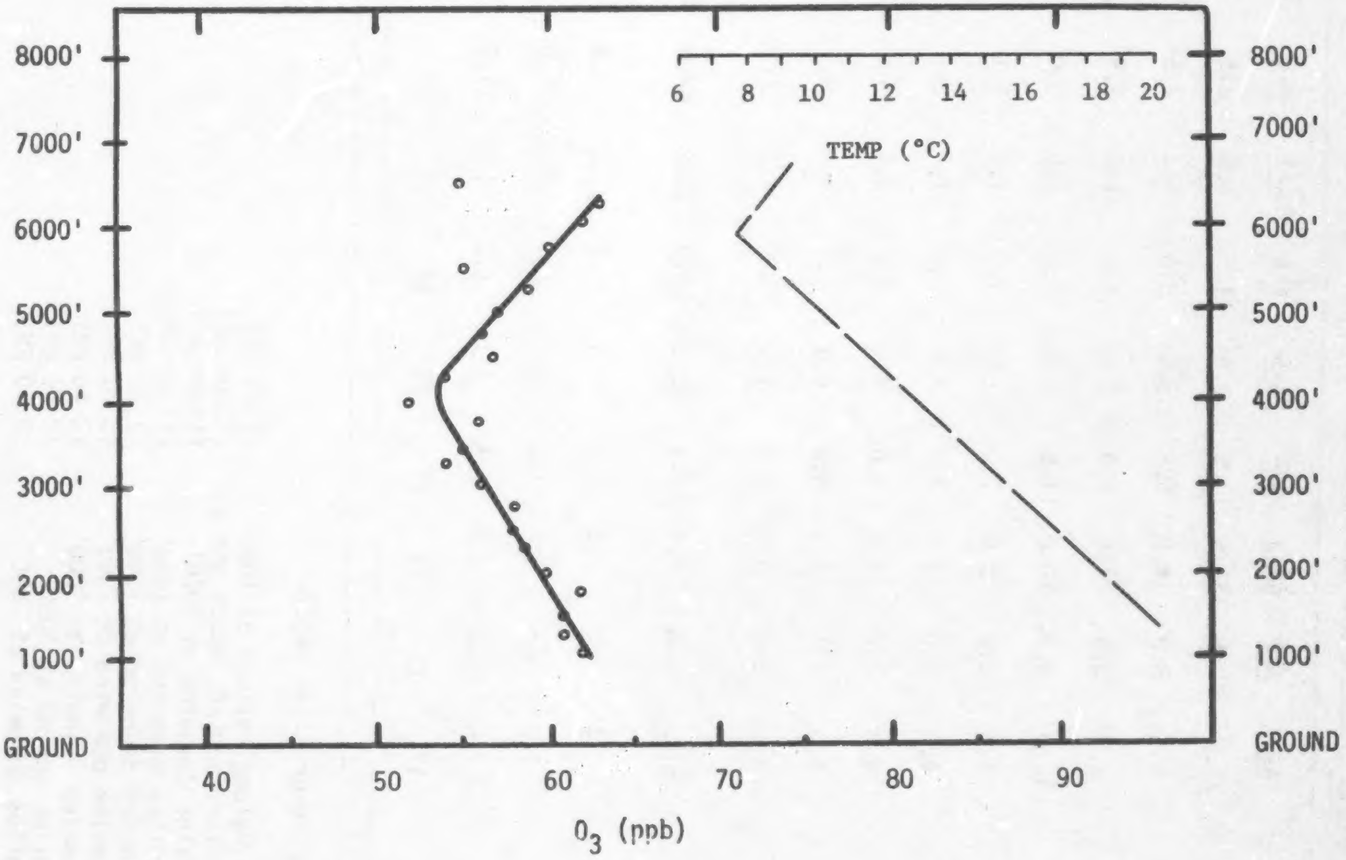

Figure B-79. Spiral climb over Malone College (8:18 pm) on July 25, 1974.

TABLE B-20. AIRCRAFT COLLECTED BAG SAMPLES. JULY 25, 1974.

	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9
Ethane	21.0	9.5	33.5	33.5	8.5	11.5	7.5	8.5	7.5
Ethylene	5.5	8.0	4.5	5.5	5.0	3.0	5.0	7.5	2.5
Acetylene	2.0	3.5	1.5	2.0	1.0	1.0	1.0	1.5	2.0
Propane	12.0	6.0	10.0	11.0	4.5	6.5	3.5	5.0	4.0
Propene	1.5	2.0	2.0	1.5	1.0	1.0	1.5	5.5	2.0
i-Butane	4.0	3.0	3.5	3.0	2.5	3.0	1.5	3.0	6.0
n-Butane	8.0	7.0	5.5	5.0	4.5	6.0	3.5	6.0	9.5
i-Pentane	5.0	7.5	8.0	4.0	4.5	5.5	5.0	8.5	6.5
n-Pentane	3.5	3.5	3.0	2.0	1.5	2.5	1.5	2.5	2.0
Total $\mu g/m^3$	62.5	50.0	71.5	67.5	33.0	40.0	30.0	48.0	42.0
NMTHC (ppm)	.5	.3	.4	.4	.3	.2	.3	.3	.3
CO (ppm)	1.2	1.5	1.1	1.2	1.1	1.1	1.3	1.0	1.7
CH_4 (ppm)	1.8	1.8	2.5	2.5	1.7	1.7	1.6	1.7	1.7
NO_x (ppb)	17	11	17	16	23	15	16	19	22

KEY (see map on previous page):

A-1	Over Malone College at 1000'	(9:40 AM)
A-2	45 miles upwind, touch and go	(10:05 AM)
A-3	6 miles downwind at 1000'	(11:15 AM)
A-4	18 miles downwind at 1000'	(11:05 AM)
A-5	16 miles downwind at 1000'	(3:10 PM)
A-6	25 miles downwind at 1000'	(3:20 PM)
A-7	45 miles downwind at 1000'	(3:40 PM)
A-8	8 miles upwind at 1000'	(8:55 PM)
A-9	6 miles downwind at 1000'	(9:10 PM)

APPENDIX C

This section provides ozone data obtained during touch and go landings at various airports in northeastern Ohio. Table C-1 lists the date, time, location and ozone concentration at various altitudes during the descending and ascending phases of the touch and go maneuver. A map showing the location of airports where this ozone data was obtained is provided in Figure C-1. The locations of the touch and go landings were also shown on the flight routes illustrated in Appendix B.

TABLE C-1. OZONE CONCENTRATIONS (PPB) RECORDED DURING TOUCH AND GO LANDINGS.

T/G#	Date	Time	Airport	Descending 1500'	1000'	500'	GND	500'	Ascending 1000'	1500'
1	7/3	10:27 am	Holmes County	65	67	66	61	65	69	65
2	7/3	11:20 am	Youngstown Executive	73	75	77	68	77	75	71
1	7/4	08:12 am	Kenley	49	54	54	41	47	55	54
2	7/4	09:11 am	Holmes County	63	49	45	41	46	53	61
1	7/8	09:33 am	Phillis Lakefront	52	50	45	44	44	48	51
2	7/8	10:30 am	Wayne County	49	37	39	34	37	39	45
1	7/9	10:22 am	Youngstown Executive	80	78	78	71	76	82	80
2	7/9	11:14 am	Holmes County	81	71	62	58	64	65	69
1	7/9	5:47 pm	Akron/Canton Regional	--	67	70	55	73	69	--
1	7/10	09:45 am	TriCity	63	54	41	42	44	44	56
2	7/10	10:20 am	Holmes County	--	84	67	46	58	82	--
1	7/11	10:24 am	Youngstown Executive	29	32	34	31	34	32	32
1	7/11	3:30 pm	Downing	71	74	76	74	72	71	70
1	7/12	09:40 am	Newcastle	52	61	49	26	52	56	53
1	7/15	09:22 am	Carroll County	40	42	38	34	36	39	41
2	7/15	10:29 am	Holmes County	--	58	56	49	58	56	54
1	7/16	09:28 am	Clever	24	22	19	20	22	22	29
2	7/16	10:19 am	Northfield	23	33	32	34	32	32	31
1	7/17	09:21 am	Carroll County	61	50	26	29	20	50	64
2	7/17	10:14 am	Magnolia	52	38	37	34	38	43	57
1	7/17	10:48 am	Weltzien	52	44	54	61	56	48	57
2	7/17	11:22 am	Akron/Canton Regional	58	62	65	69	74	81	82
1	7/17	4:10 pm	Akron Municipal	120	109	103	96	100	92	87
1	7/18	10:17 am	Geauga County	--	91	94	88	94	90	85
1	7/19	09:34 am	Columbiana County	56	54	52	52	56	57	55
2	7/19	10:25 am	Weltzien	51	52	53	48	50	51	56
1	7/20	10:54 am	Clever	28	30	31	29	30	30	30
1	7/22	10:37 am	Weltzien	61	48	224	17	20	41	61
1	7/25	10:08 am	Steubenville-Pier	52	46	39	39	39	50	47
2	7/25	11:03 am	Weltzien	52	44	44	34	43	40	42

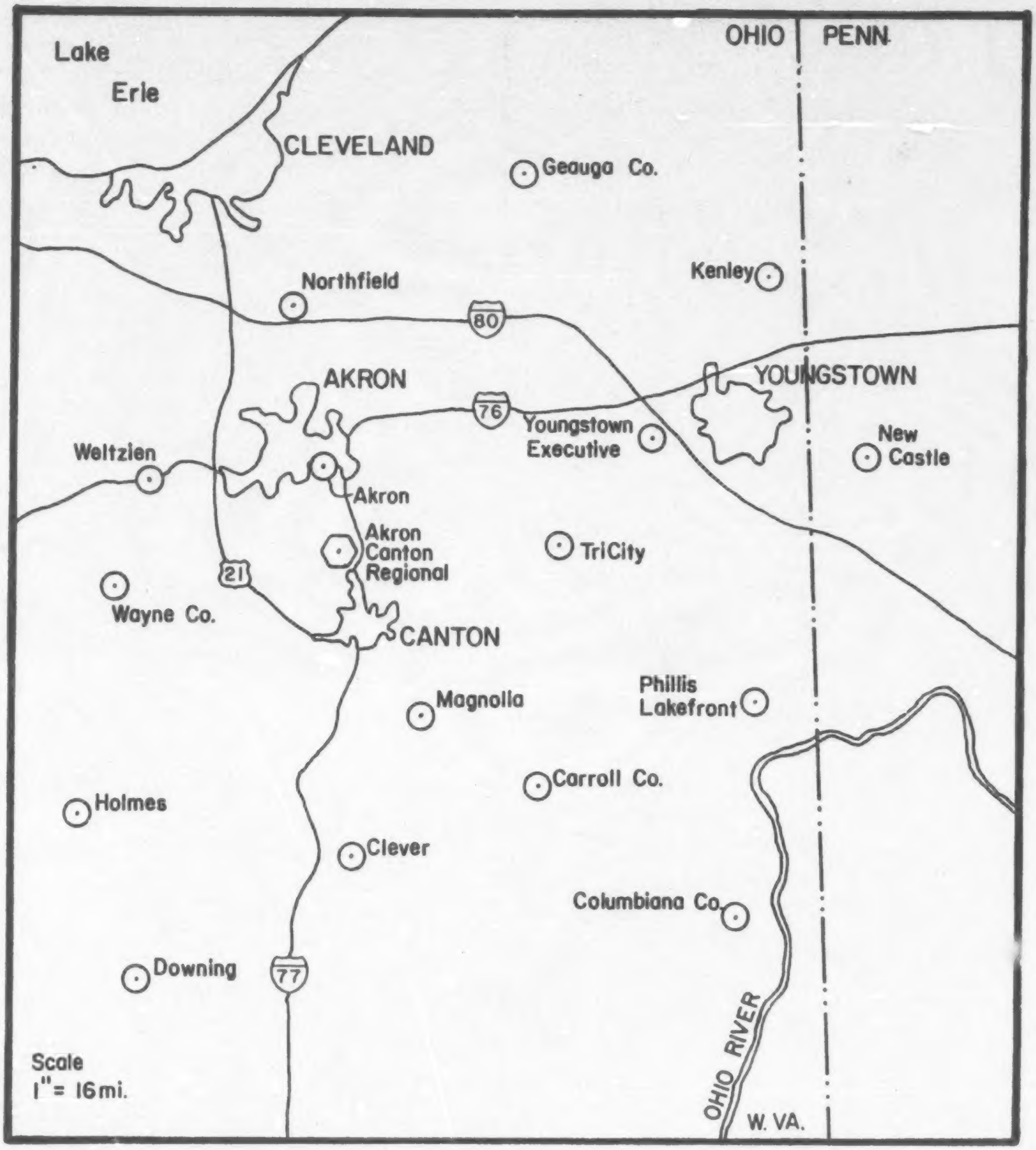
Lake
Erie
OHIO
PENN
CLEVELAND
Geauga Co.
Kenley
Northfield
80
AKRON
YOUNGSTOWN
76
Youngstown Executive
New Castle
Weltzien
Akron
Akron Canton Regional
TriCity
21
Wayne Co.
CANTON
Magnolia
Phillis Lakefront
Carroll Co.
Holmes
Clever
Columbiana Co.
Downing
77
OHIO RIVER
Scale
1" = 16 mi.
W. VA.

Figure C-1 . Location of airports used for touch and go landing.